

The **AMSAT**[®] Journal

Volume 27, Number 3

May/June 2004

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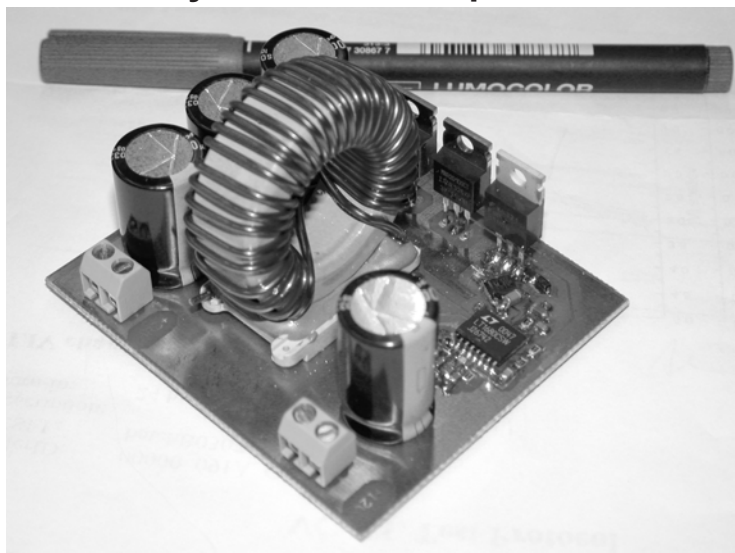
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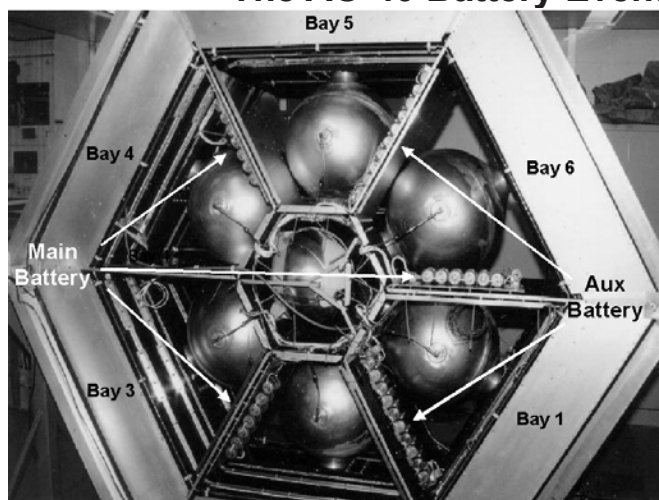
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Power for your 28VDC Amplifiers



The AO-40 Battery Event



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SATELLITE AWARDS

by Bruce Paige, KK5DO • kk5do@amsat.org

Congratulations go out to those that have recently made their very first satellite QSO. May they have many more years of fun on the satellites.

Roger Stout, N4RWS
Maciej Jakimiec, SP2SGF
Tim Hayes, N0MAP
Robert Fairfield, K7RQN

Congratulations go out to all of the following for earning their Oscar Satellite Communications Achievement Award.

#393 Edward Lock, KE8FK, 28-Jan-2004
#394 Luc Leblanc, VE2DWE, 20-Mar-2004

Congratulations also go out to the following for earning their South Africa Communications Achievement Award.

#US80 Ron Nutter, KA4KYI, 3-Mar-04

Congratulations go out to the following for earning their W4AMI Award.

#38 Albert Ozias, N7EQF, 6 Feb 04 1,000;
2,000; 3,000 and 4,000 Level
#36 Emily Clarke, W0EEC, 3 Mar 04 3,000
and 4,000 Level
#17 Albert Ozias, N7EQF, 6 Feb 04 5,000
Level
#18 Emily Clarke, W0EEC, 4 Mar 04 5,000
Level

Finally, congratulations go out to the following for earning their AMSAT Oscar Sexagesimal Award.

#133 Emily Clarke, W0EEC, 8-Jan-04
#134 Scott Migaldi, K9PO, 17-Feb-04

To see all the awards and a list of those earning the awards, visit <http://www.amsatnet.com/awards.html>

73,

Bruce Paige, KK5DO

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy high earth orbit satellite systems that offer daily coverage by 2009 and continuous coverage by 2012. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.



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AMSAT-NA website: <http://www.amsat.org>

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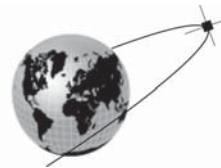
The AMSAT Journal (ISSN: 1407-3076) is published bi-monthly (Jan, Mar, May, Jul, Sep, Nov) by AMSAT-NA, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703. Telephone: 301-589-6062, fax: 301-608-3410. Periodicals postage paid at Silver Spring, MD and additional mailing offices. **Postmaster:** Send address changes to *The AMSAT Journal*, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703.

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APOGEE VIEW

by Robin Haighton, VE3FRH • ve3frh@amsat.org



AMSAT-NA is undergoing a major change in its life as an organization. Remember we started life some 35 years ago as a small group of satellite enthusiasts who met in Perry Klein's apartment in Washington, DC. We inherited the skills and ideas from Project OSCAR and cooperated with Australia in the building of AO-5 (Australis). Designing, building and launching OSCARS 6, 7 and 8 encouraged other AMSAT organizations around the world to be formed and to start building their first satellites. Two of the very first satellites are still with us, AO-7 and UO-11, a great compliment to their builders and to the technology of the time.

In cooperation with AMSAT-DL the P3 series of satellites was developed and OSCAR 10 (P3B) is still occasionally operational.

AO-13 (P3C) was a great success but unfortunately gravitational effects of Sun, Moon and Earth eventually took their toll. As recently as July 1991, a series of Microsats (were successfully launched to be followed by the KitSats from Korea and Japanese satellites.

In the early 1990's planning, designing and building of the P3D took a great deal of time and effort, but by the time AO-40 was ready for launch, there had been 39 OSCAR satellites and 15 RS satellites from Russia.

P3D was the 40th OSCAR satellite and, in spite of several problems, has provided world wide communications on S-band for over 3 years. In addition it was our first successful venture into K-band, a very noteworthy achievement.

Since the launch of AO-40, we have now reached OSCAR 50 with several more to be launched this summer, including our own Echo. Not bad for an organization of Amateurs!

However, up to now the President of AMSAT-NA has been directly responsible for the day-to-day operations in conjunction with the only AMSAT employee - Martha. Nearly all policies that have been developed have been executed by the President and Martha, with only a few exceptions. Now it is proposed to make changes in this area, and to distribute "the load" between active teams of volunteers.

At a recent strategy meeting, involving the Board of Directors and the senior officers of AMSAT, it was recognized that a change is both desirable (from the President's view) and necessary if we are to attract future Presidents. The strategic planning group has

been holding regular teleconferences to determine the best ways to implement these moves and I hope that by our Annual General Meeting in October we will be in a position to have a working trial system.

Meanwhile, we are also carrying out a detailed membership survey to determine the needs of the membership and to try and see that your needs are factored into AMSAT strategy.

Those of you who have received the AMSAT survey (selected at random) will be pleased to note that each member of the BoD has also received a copy of the survey. Each of us will have charted our results against the results of the membership - we will then know if we are really representing you!

If you were selected to receive the survey and have not yet returned it, please do so as quickly as possible, it really is your turn to give us your input.

73,
Robin Haighton VE3FRH
President AMSAT-NA 

2004 AMSAT Space Symposium and Annual Meeting - Call for Papers

This is the first call for papers for the 2004 AMSAT Space Symposium and Annual Meeting to be held October 8-10 in Arlington, Virginia. This symposium will be held in conjunction with the ARISS International Meeting that is planned for October 10-13.

Proposals for papers, symposium presentations and poster presentations are invited on any topic of interest to the amateur satellite program. An emphasis for this year is AMSAT's educational outreach activities, including our educational outreach efforts with universities and the International Space Station. In particular, papers on the following topics are solicited:

Students & Education, ARISS, Echo, Eagle and other satellite-related topics.

We request a one-page abstract by June 1, 2004. Camera-ready copy on paper or in electronic form will be due by August 1, 2004 for inclusion in the printed symposium proceedings.

Abstracts and papers should be sent to:

Daniel Schultz N8FGV
14612 Dowling Drive
Burtonsville, MD 20866
or by e-mail to: n8fgv@amsat.org



What is AMSAT®?

AMSAT members are a worldwide group of enthusiastic individuals designing, building and operating Amateur Radio satellites as part of our program of space science education.

The Radio Amateur Satellite Corporation (AMSAT or AMSAT-NA) is a non-profit scientific and educational organization chartered in Washington, DC, in 1969. Since then, AMSAT and colleague organizations around the world have built over 50 ham radio satellites. Fifteen of these satellites continue in operation.

Joining AMSAT supports our current projects: Eagle, AMSAT-OSCAR-E (Echo) and ARISS. Eagle is a high orbit DX capable satellite planned for a 2007 launch. Echo is a low orbit FM and digital bird you will be able to use with simple equipment, planned for launch in 2004. And ARISS is our program on the International Space Station. You will keep up to date on the world of Amateur Radio satellites with 6 issues of the AMSAT Journal every year.



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Included at the amsat.org Web site are forms for single sided printing ... just print, cut, fold and mail. You can also find forms for double sided printing if you prefer.

You can find the AMSAT QSL inserts on-line at:

<http://www.amsat.org/amsat/amsat-na/membership.html>

(right) Rick Hambly, W2GPS, AMSAT Executive VP, shown viewing the AMSAT QSL insert.



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Experimental Investigation of Quadrifilar Helix Antennas for 2400 MHz

by Domenico Marini, I8CVS, domenico.i8cvs@tin.it

This article originally appeared in a slightly different form in the December/February 2003/2004 AMSAT-DL Journal.

Additional translation assistance was provided by Reinhard Richter.

The Quadrifilar Helix antenna as shown in Figure 1 has already been described in detail and discussed in references [1], [2], [3], [4]. That discussion will not be repeated here. Unfortunately, very little has been written on how to build a Quadrifilar Helix antenna to radiate with RHCP (Right Hand Circular Polarization) or with LHCP (Left Hand Circular Polarization).

To test the radiation characteristics of a Quadrifilar Helix antenna, four prototypes were built for 2400 MHz. As can be seen from Figure 1, RHCP or LHCP is achieved if both loops are wound in the reverse direction of the desired field rotation so that LHCP is achieved by winding both loops right hand and RHCP by winding both loops left hand, which is exactly the opposite of a W8JK type helix antenna.

Figure 2 contains the design details. Half of the small bifilar loop was made of semi-rigid coaxial cable, UT-047. Silver plated copper wire with a diameter of 1.2 mm was used for the other half of the small bifilar loop and for the entire larger, second bifilar loop.

In Figure 2 the ends of the loops are connected to a so-called infinite balun having a phase relationship that here reinforces the field in the upward direction to generate endfire radiation. That cancels the field toward the SMA connector and feed point.

In Figure 3 it can be seen how the small and the large bifilar loops of a RHCP Quadrifilar Helix are wound in the left-hand direction and are connected to the infinite balun having a phase relationship that reinforces the field in the downward direction to generate a backfire radiation that reinforces the right-hand circular field toward the feedpoint and creates a null in the upward direction of the picture in Figure 3.

Because the phase relationship in Figures 2 and 3 produces currents that reinforce the field in one direction and a field cancellation in the opposite direction, then both the above RHCP Quadrifilar Helix antennas become

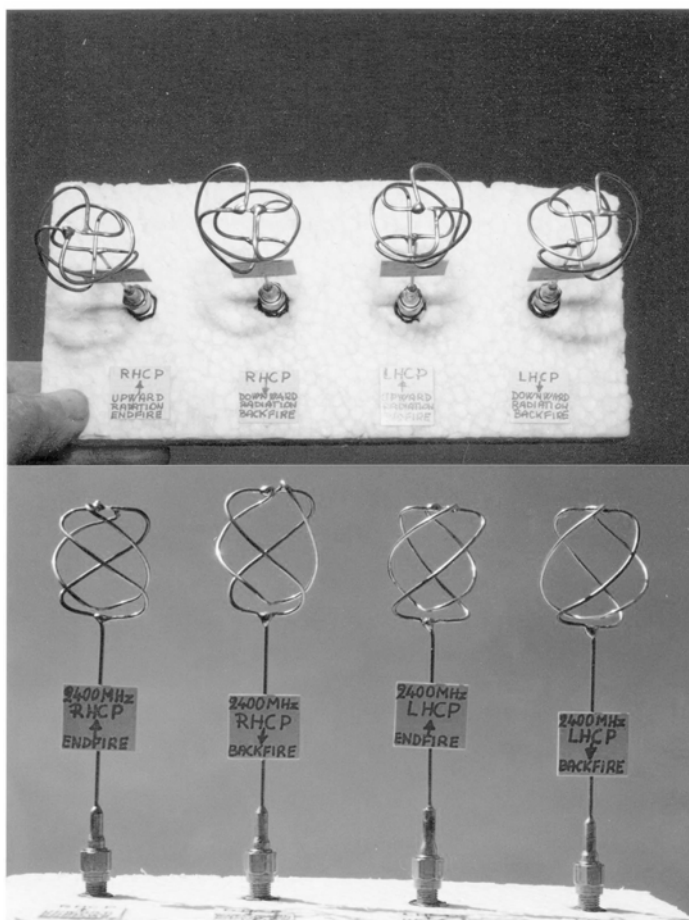


Figure 1
Four sample Quadrifilar Antennas

a directional antenna, which does not need a reflector.

Figure 4 shows an enlarged view of the infinite balun, which is connected for endfire RHCP, as is shown in Polar Plot 1. In Figure 4 the RHCP radiation pattern points in the direction of the viewer. The interconnection for RHCP backfire radiation is shown in Figure 5 with the pattern shown in Polar Plot 2. In Figure 5 the RHCP radiation takes place in the opposite direction of the viewer and so is toward the feedpoint.

Figure 6 shows an enlarged view of the infinite balun, which is connected for LHCP endfire radiation, which is shown in Polar Plot 3. In Figure 6 the LHCP radiation pattern points at the viewer. In Figure 7 the interconnection for LHCP backfire radiation is shown in accordance with Polar Plot 4. In Figure 7 the LHCP radiation takes place in the opposite direction of the viewer and so toward the feedpoint.

The radiation pattern in Polar Plot 1 shows the result of these experiments for a RHCP Quadrifilar Helix antenna with endfire radiation. Polar Plot 2 shows the same for a RHCP Quadrifilar Helix antenna with backfire radiation.

As a further explanation, endfire radiation by definition takes place opposite to the feed point while backfire radiation points toward the feed point of the antenna. See Polar Plots 1 to 4.

During experimentation with connections of the loops to the infinite balun has been found that a connection producing endfire radiation in a RHCP Quadrifilar generates backfire radiation in a LHCP Quadrifilar as shown comparing Figure 4 to Figure 6. Likewise connections producing endfire radiation in a LHCP Quadrifilar generates backfire radiation in a RHCP Quadrifilar as shown comparing Figure 6 to Figure 5.

Another point, which has not been discussed in great detail in the references, is the feeding and

phasing method with help of the infinite balun. This make it possible the self matching of the loop elements to a 50 ohm line as well to feed the loop element in such a way that either circular endfire radiation or circular backfire radiation can be achieved depending on loop connections to the infinite balun as schematically illustrated in each of the radiation patterns.

The gain of a Quadrifilar Helix antenna amounts to about 5 dBi and radiation patterns from Polar Plots 1-4 show that the major lobe of this type of antenna is very well suited to be used as a feed to illuminate dishes with a f/D ratio of 0.3. Because the illumination angle for feed at the edge of the dish is approximately 159 degrees, the space attenuation is 4.6 dB and the desired taper is 5.4 dB for -10 dB edge illumination.

A further advantage of the Quadrifilar Helix antenna compared to a helix or to a patch used as a feed in a parabolic dish is its small size because the Quadrifilar Helix Antenna is a directional antenna which does not need a reflector, so that the shadow, which a

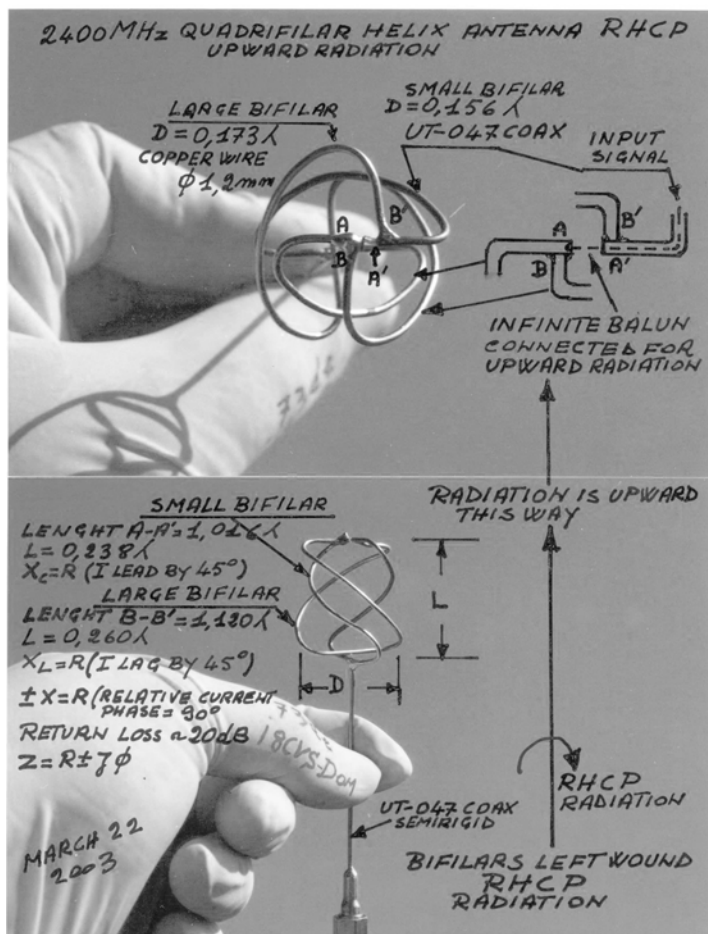


Figure 2 (above)
Construction of the RHCP-Endfire Type

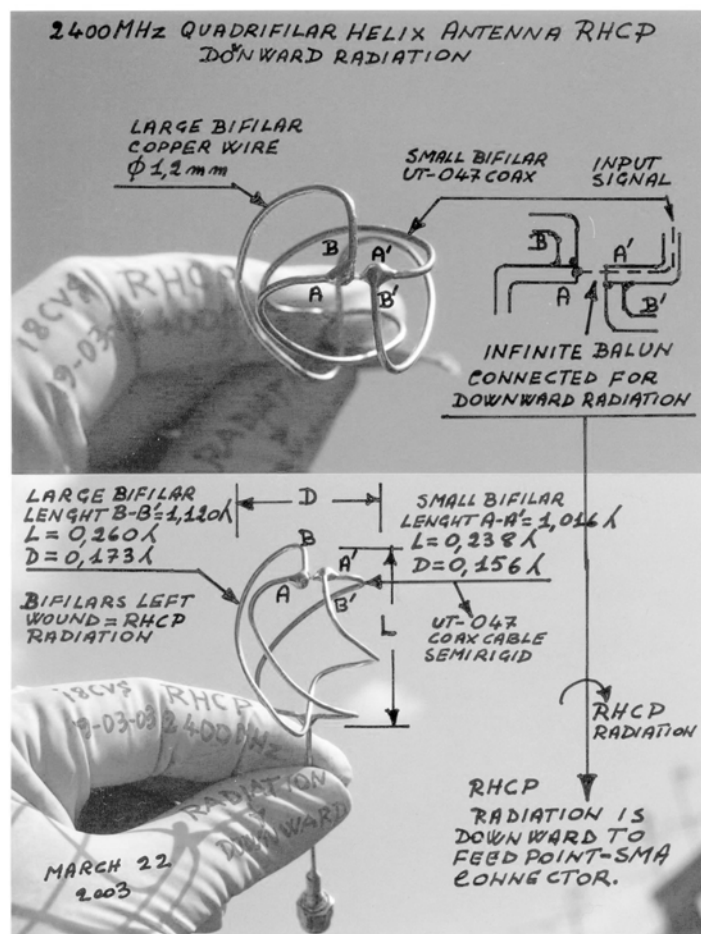


Figure 3 (above)
Construction of the RHCP-Backfire Type

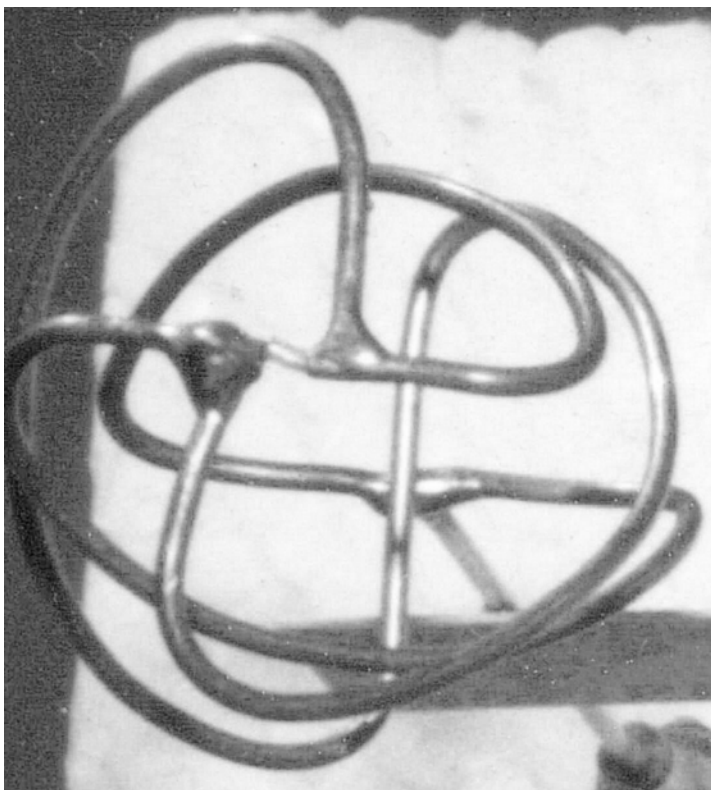


Figure 4 (above)
Detail photograph of the RHCP-Endfire

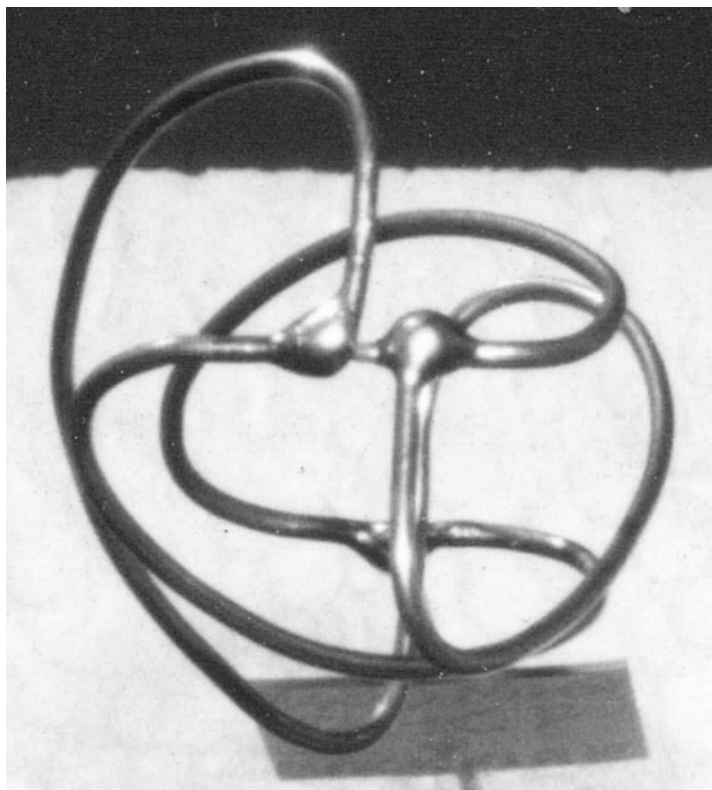
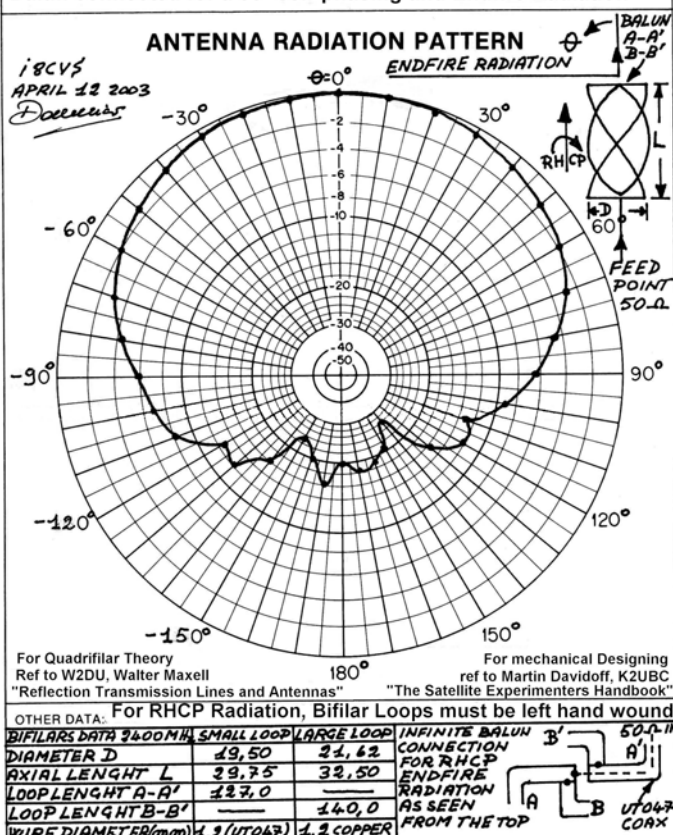


Figure 5 (above)
Detail photograph of the RHCP-Backfire

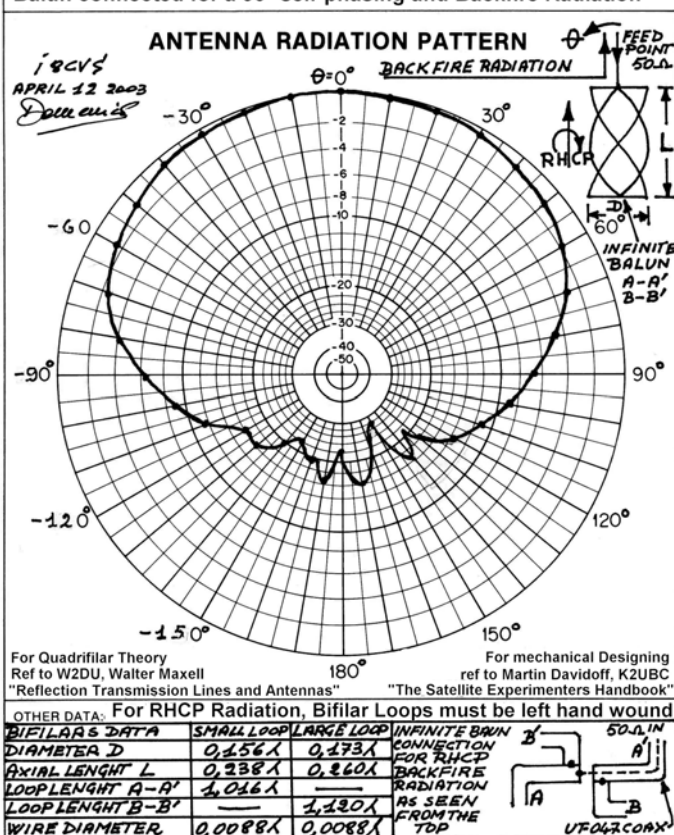
Radiation Pattern of a 2400 MHz RHCP Quadrifilar Helix Antenna when illuminated by a RHCP Source (RHCP Patch) and infinite Balun connected for a 90° self-phasing and Endfire Radiation



Polar Plot 1 (above)

Radiation characteristics of the Endfire-RHCP with several dimensions and construction hints.

Radiation Pattern of a 2400 MHz RHCP Quadrifilar Helix Antenna when illuminated by a RHCP Source (RHCP Patch) and infinite Balun connected for a 90° self-phasing and Backfire Radiation



Polar Plot 2 (above)

Radiation characteristics and hints for the Backfire-RHCP.

reflector can produce with a small diameter dish, can be neglected and thus increase the overall efficiency of the dish.

In addition to the above advantage, a dish with $f/D=0.3$ or less has only a small spillover since its focal length is short and the feed is close to the bottom of the dish. These conditions improve the G/T ratio of the system in comparison to other receiving systems, which use the same receiver to a dish with the same diameter but larger f/D ratios.

Since a parabolic dish reverses by reflection the direction of polarization of a circularly polarized wave, then a LHCP Quadrifilar Helix antenna is needed as a parabolic feed to receive a RHCP signal transmitted by AO-40. For this reason two LHCP prototypes for 2400 MHz were built. The first one was connected for LHCP endfire radiation as shown in Figure 6 and Polar Plot 3 and the second one was connected for LHCP backfire radiation as shown in Figure 7 and Polar Plot 4.

In the case of a feed with a LHCP endfire radiation pattern as in Polar Plot 3 mounted in a dish, the Quadrifilar Helix must point toward the dish and the SMA connector for

the downconverter must point outward to the outer space. This is the best method for mounting the feed. On the other hand, in the case of a feed with a LHCP backfire radiation pattern as in Polar Plot 4 the helix must point to the outer space and the SMA connector for the downconverter must point toward the dish.

During the above experimental investigation it was found that another desirable characteristic of a Quadrifilar Helix antenna used as a feed in a parabolic dish is its circularity, as shown in Polar Plot 5.

To measure the circularity a RHCP endfire Quadrifilar Helix antenna was installed in front of a half wave slowly spinning dipole, which was fed by a signal generator through a rotating coaxial joint. As shown in Polar Plot 5, the Quadrifilar Helix was directed first toward the spinning dipole, which was at an angle of 0 degrees. The signal received from a spectrum analyzer was measured and resulted in the curve marked "circularity at 0", which had a maximum axial ratio of only 1 dB between the 0 degree and 180 degree points of the polar plots.

Then the axis of radiation of the Quadrifilar Helix was changed by 30 degrees in relation

to the slowly spinning dipole and the circularity Polar Plot was again measured. This resulted in the curve marked "circularity at 30°" which showed a maximum axial ratio of only 1 dB in the case of the 90 degree and 270 degree points on the polar plots. Similarly the Quadrifilar Helix antenna was turned by 60 degrees relative to the spinning dipole, and the curve resulted in an axial ratio of 3 dB maximum between the 90 and 270 degree points of the polar plots.

And finally the Quadrifilar Helix antenna was turned by 90 degrees relative to the spinning dipole and the maximum axial ratio was measured at 16 dB at the 90 and 270 degree points. However, it decreased by less than 1 dB at the 0 and 180 degree points, as can be seen in the curve marked "circularity at 90°". The Polar Plot circularity indicates that a Quadrifilar Helix antenna is ideal for illuminating the entire surface of a dish with very good circular polarization and has a very small axial ratio from the center of the dish to about its edge.

During the above experimental investigation the unknown circularity direction of a Quadrifilar Helix antenna was determined

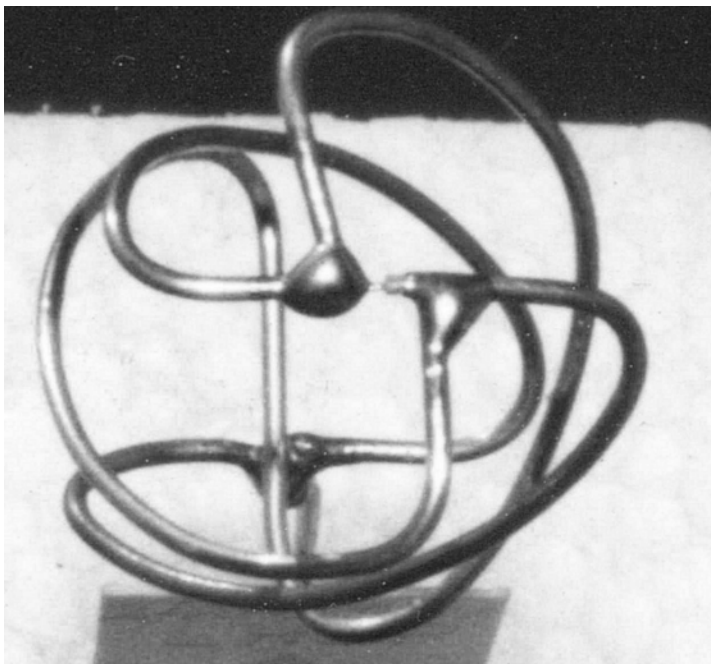


Figure 6 (above)
Detail photograph of the LHCP-Endfire.

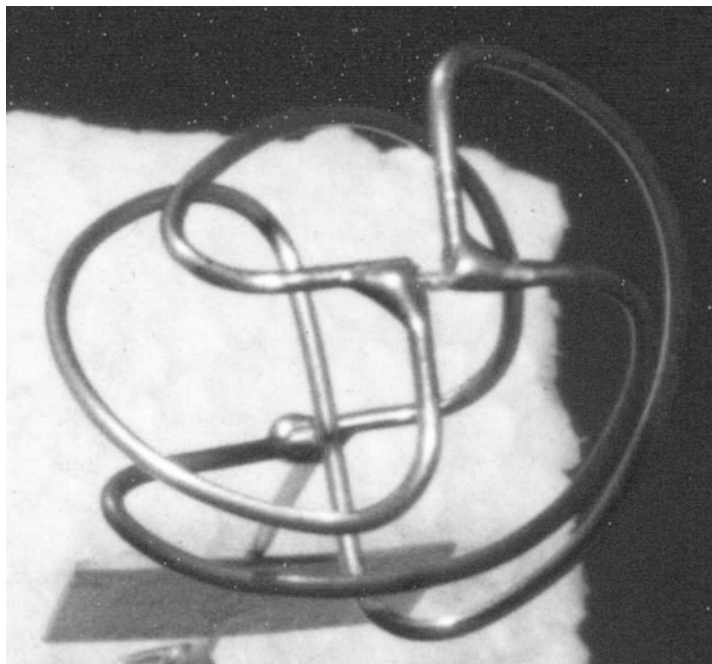


Figure 7 (above)
Detail photograph of the LHCP-Backfire.

against a reference patch antenna connected for LHCP. A 2400 MHz signal generator as a transmitter drove the patch antenna while the Quadrifilar Helix antenna was connected to a spectrum analyzer as a receiver as seen in Figure 8. If the output from the Quadrifilar Helix antenna remains constant or varies very little, by less than 1 dB, as the patch is rotated manually through 360°, then the Quadrifilar Helix antenna under test is also LHCP. If, however, there are two deep nulls and two peaks observed when rotating the source patch antenna through 360°, then the Quadrifilar Helix antenna under test has opposite polarization or RHCP in this example.

For those who would like to build and duplicate the Quadrifilar Helix antenna for RHCP or LHCP all of the electrical dimensions and materials to be used as well as winding directions for the smaller and larger loops are given in their respective illustrations, Figures 2 to 5. For still more detailed construction designs consult the references (3) and (4). For those who would like to know more about the theory and how Quadrifilar Helix antennas function in general and who want to learn more details of the workings of infinite baluns, including how the 90 degree phase shift for circular polarization as well as the self-matching to a 50 ohm-feedline takes place, should

definitely study the references (1) and (2).

An additional article being planned will deal with the results obtained with a Quadrifilar Helix antenna for 2400 MHz used as a feed on dishes with f/D ratio ranging from 0.3 to 0.35 hopefully using the RHCP medium beacon of AO-40 otherwise using the 2401.500 MHz LHCP beacon of UO-11.

References:

- [1] "Reflection Transmission Lines and Antennas" by M. Walter Maxwell, W2DU, ARRL, order no. 2995, ISBN 0-87259-299-5.
- [2] "The ARRL Antenna Book" published by The American Radio Relay League (ARRL).
- [3] "The Satellite Experimenters Handbook" by Martin Davidoff, K2UBC, second edition, ARRL order No. 3185.
- [4] "The AMSAT Journal", March/April 1994, "Quadrifilar Antennas for Amateur and 137 MHz Satellites", by Dave Guimont, WB6LLO. 

Figures continue on the next page.

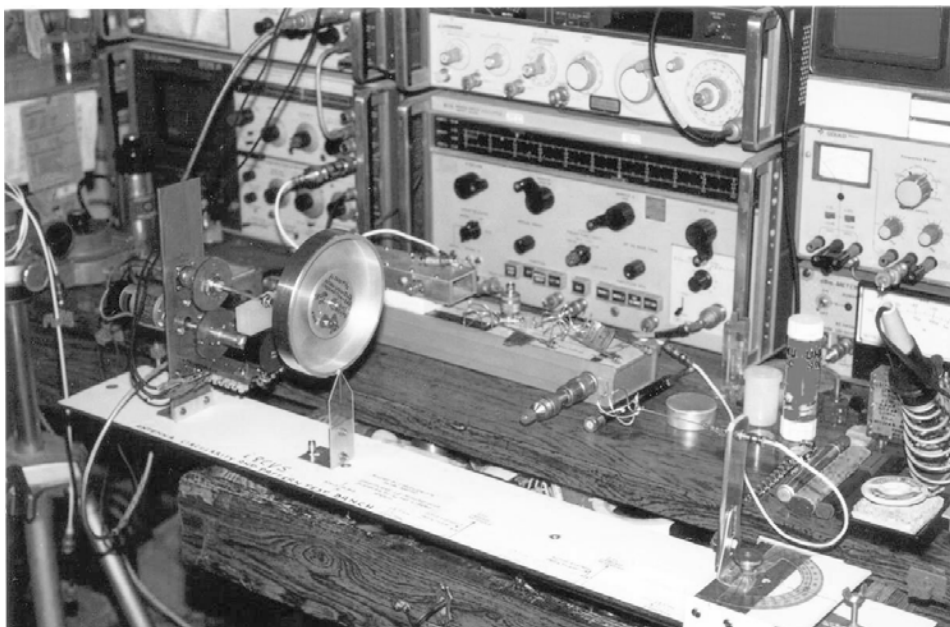
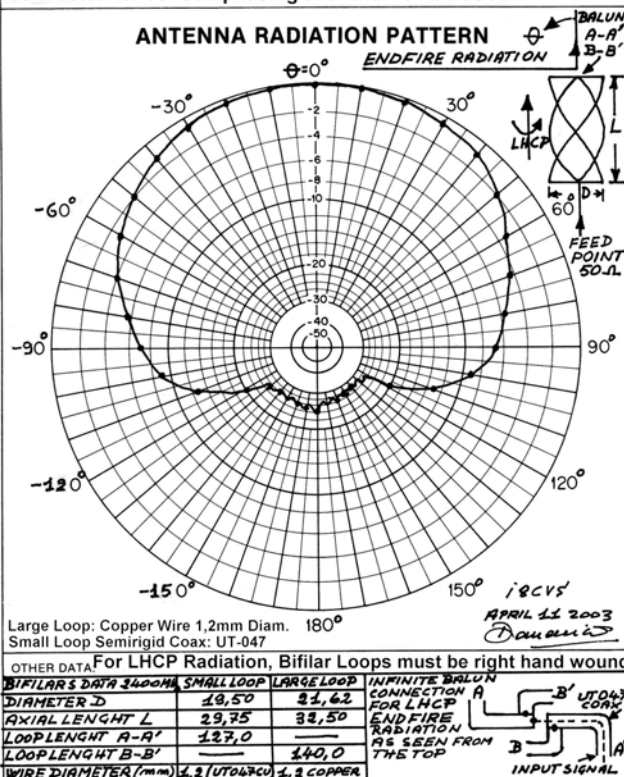


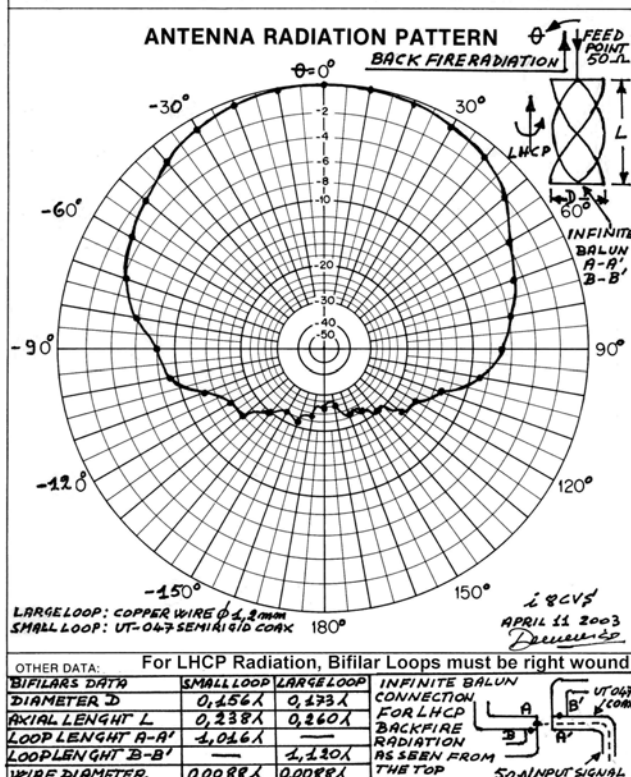
Figure 8 (left)
Measurement bench to determine the unknown circularity direction of a Quadrifilar-Helix antenna against a reference patch antenna connected for LHCP (see text).

Radiation Pattern of a 2400 MHz LHCP Quadrifilar Helix Antenna when illuminated by a LHCP Source (LHCP) and infinite Balun connected for 90° self-phasing and Endfire Radiation



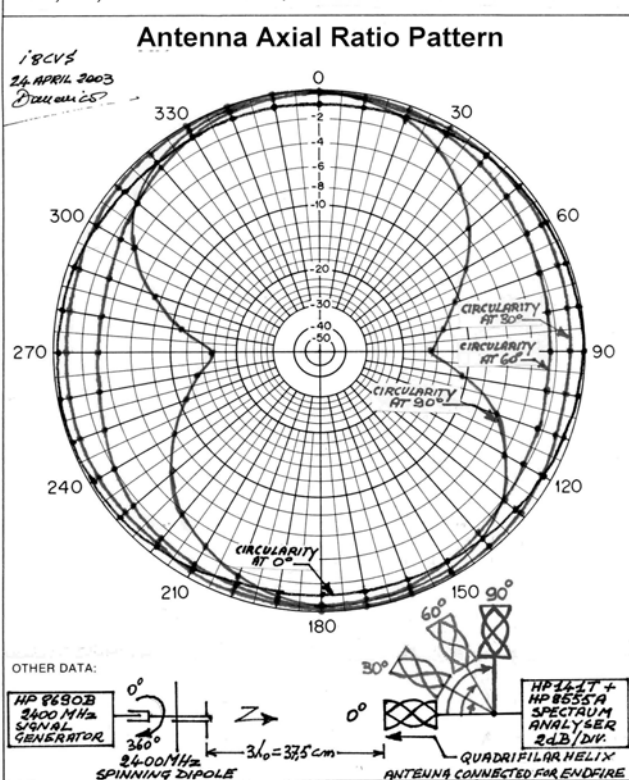
Polar Plot 3 (above)
Radiation characteristics and hints for the Endfire-LHCP.

Radiation Pattern of a 2400 MHz LHCP Quadrifilar Helix Antenna when illuminated by a LHCP Source (LHCP Patch) and infinite Balun connected for 90° self-phasing and Backfire Radiation



Polar Plot 4 (above)
Radiation characteristics and hints for the Backfire-LHCP.

Circularity Diagram of a 2400 MHz RHCP Endfire Quadrifilar Helix Antenna when illuminated by a $\lambda/2$ spinning dipole at 0°, 30°, 60° and 90° from Quadrifilar Helix Radiation Axis



Polar Plot 5 (left)
Antenna axial ratio pattern and measurement bench to determine the circularity of the Quadrifilar-Helix at different squint angles against a spinning half wave dipole.

AMSAT-NA Board of Directors Nominations

This is a reminder that nominations for the AMSAT-NA Board of Directors must arrive at the AMSAT office (850 Sligo Ave #600, Silver Spring, MD 20910) no later than June 15th. Member Societies or 5 current AMSAT members may make nominations of fellow members to serve a two-year term. Three seats on the seven-member board must be filled. Those whose terms are expiring are: Tom Clark, W3IW1, Lou McFadin, W5DID and Bruce Paige, KK5DO.

73,
Martha Saragovitz
Corporate Secretary

Further to ANS-095, 3 April 2004, I am pleased to report that the procedures recently adopted by IARU Region 1 (Europe, Russia, Middle East and Africa) described there for reporting illegal non-amateur interference to amateur satellite uplinks have now also been adopted in IARU Region 2 (the Western Hemisphere), with only one small difference. Because IARU R2 does not have a regional satellite coordinator, as does IARU R1, we in R2 are asking those reporting such interference, and their national societies, to send copies of their reports to the IARU Satellite Advisor (ZS6AKV) and his Advisory Panel at satcoord@iaru.org.

Steps to identify and help eliminate such interference will be coordinated among all three IARU Regions, at two levels: through the Satellite Advisor and Advisory Panel, and also through the worldwide IARU Monitoring Service organization, including MS Coordinator Bob Knowles, ZL1BAD, and his three regional coordinators.

I am appending today's e-mail sent to IARU member societies in Region 2 by Martin Potter, VE3OAT, IARU R2 MS Coordinator, outlining Region 2's program and describing (through links to the IARU R2 MS Web site) the procedures and reporting information desired.

Please include a note about this in an ANS Bulletin and a forthcoming issue of *The AMSAT Journal*.

Many thanks,
Ray Soifer, W2RS

To: All IARU Member Societies in Region 2

I would like to inform you of a small change in the operation of the IARU Region 2 Monitoring System, concerning intrusions in the VHF/UHF amateur bands and interference to amateur satellites.

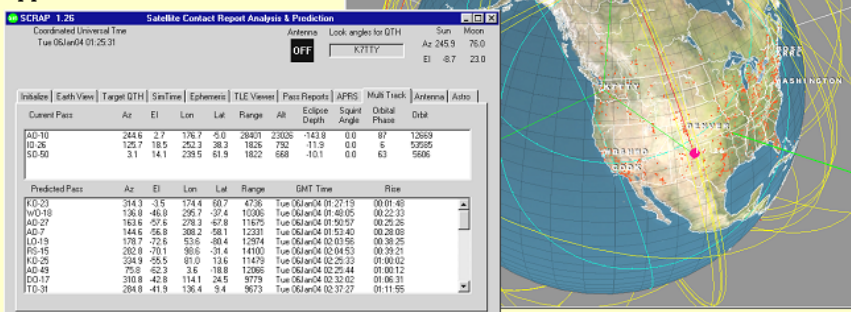
Historically, the Monitoring System has concentrated on the HF bands, and has ignored the VHF and UHF bands where interference has tended to be local and almost always within national borders. Now, however, when intruders use the same VHF and UHF frequencies already used by amateur satellite uplinks, the resulting interference crosses many borders.

Several years ago in cooperation with AMSAT-NA, the Region 2 Monitoring System developed a simple, informal arrangement to deal successfully with a particular instance of this problem. Further, at the 2001 Region 2 conference in Guatemala, a recommendation was passed (Annex C to the Report of Committee "C",

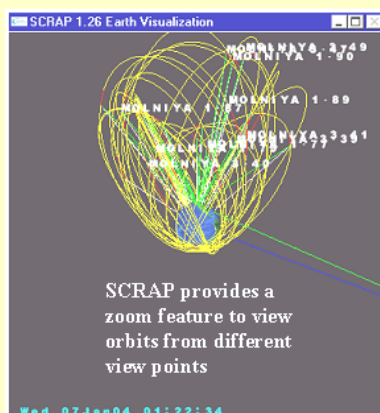
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Satellite Contact Report Analysis Prediction

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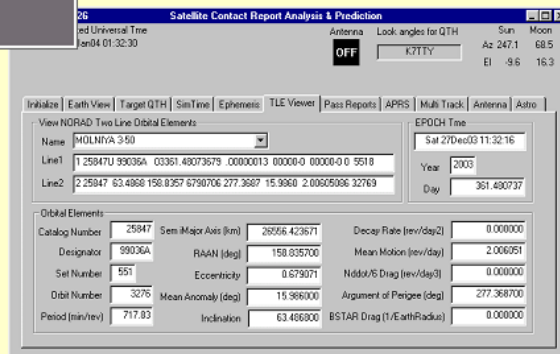
SCRAP provides a real-time contact report and display for over 2000 satellites on a Microsoft Windows 95+ Pentium platform.



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A 12V Input Switched Mode Power Supply for 28V LDMOS Power Amplifiers

by Achim Vollhardt, DH2VA, dh2va@amsat.org

This article was published first in DUBUS magazine, issue 1/2004. Reprinted with the kind permission of the DUBUS editor.

In recent months, LDMOS power amplifiers for 23 cm have become more and more popular. While these new devices have better efficiency (50% vs. 35%) than the well-known Mitsubishi modules, the supply voltage of 28V is new to most hams. Although higher voltages result in lower currents and therefore fewer problems with contact resistances, most ham radio stations are based on a 12V main supply voltage. This is particularly true for portable stations as they rely on lead acid batteries as the main power source. With the appearance of these new PA units the need for a simple, highly efficient power supply has arisen.

Due to the ongoing development of switched mode power supply circuits many devices and applications are available. Even for newcomers who are familiar only with standard linear regulators like the 78XX/79XX family, switched power supplies are becoming a real alternative when dealing with high power applications. As a target example, a power supply for the G3WDG 50W PA will be presented.

Component Selection

The power requirements of the G3WDG 23 cm PA are 28V @ 4.5A max. (126W). To generate this voltage from a 12V source we are going to use the so-called boost topology, which is sketched in Figure 1.

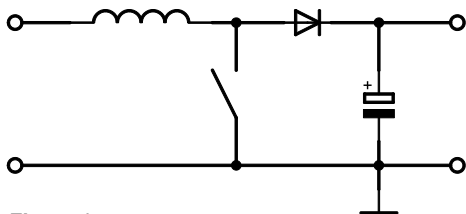


Figure 1
Switching regulator boost topology

Basic components of a switching regulator are the inductor, the diode and the switch (which is essentially a MOSFET). When arranged in this boost topology the input voltage is increased (boosted) to a higher value. For a more in depth discussion of a boost converter see Reference 1. When looking at the schematics we can start identifying the first possible sources of power losses, which will become important later:

- The ohmic resistance of the inductor
- The ohmic resistance of the switch when turned on
- The forward voltage drop of the diode

To complete the boost topology of a full switching regulator we need a feedback circuit, which controls the regulator's properties according to load demands. While circuits like this had to be built with discrete components previously, the industry is providing us today with several highly integrated switching power supply controllers, which include overcurrent sensing, soft start features and a sense feedback for adjusting the output voltage. I chose the LT1680 from Linear Technologies for this application as this device is specifically made for a boost topology based on a 12V input. In addition, this controller is able to handle the high gate capacitances that are a characteristic of the high power MOSFET switching devices used.

In addition to the controller IC the inductor is the central device in such a converter. It must be able to provide the needed inductance for the switching converter operation even when biased with a high current. When the rated current is exceeded the core won't be able to handle any more magnetic flux and the inductor saturates. This can result sometimes in catastrophic failure modes and is a key reason many people do not like to build switched mode regulators. Therefore, one has to be very careful when selecting the inductor. When in doubt, select the larger one! In this case, I chose the DMT-3 inductor from Coilcraft, which happens to be the largest inductor in their catalogue. According to its datasheet it is able to sustain 35 uH of inductance when biased with 12A. This will be necessary as our converter will sink over 10A from its power supply when operating at 100 % efficiency and even more if we lose some efficiency, which we certainly will.

The next component to choose is the MOSFET switch. Basic parameters like maximum V_{DS} and I_{DS} should be well above 28V and 12A respectively. To minimize ohmic losses during the MOSFET's on time look for lowest possible $R_{DS(on)}$. This should be in the order of 10 milliohms. In addition, there is another loss mechanism not mentioned before – the dynamic losses of a MOSFET switch. An ideal mechanical switch has $R_{ON} = 0$ and $R_{OFF} = \infty$ with an instant transition between on and off states. In both cases no power is lost in the switch. A real MOSFET switch, however, has inherent rise and fall times where the on resistance has a finite value and therefore the MOSFET dissipates power while

conducting. This power can easily be calculated:

$$P = 0.5 * V_{out} * (I_{out} / (1-DC)) * (T_r + T_f) * f$$

where $1-DC = V_{in}/V_{out}$, (DC: Duty Cycle), the switching frequency is f .

It can be seen that the rise and fall times can significantly contribute to converter losses. To minimize these I chose the FQP85N06 MOSFET. With an $R_{DS(on)}$ of 10 milliohms and rise and fall times around 200 ns, this is a very good device for this application. Of course, this is only true if the gate can be charged and discharged faster than 200 ns. Even with the cited LT1680 controller this can be a problem as we deal here with times in the order of 200 ns and gate capacitances of 5 nF and more. A simple calculation shows us, that $12V * 5 nF = 60 nC$, $60 nC / 200 ns = 0.3A$. This means, that our gate driving circuit has to be able to drive a current pulse of more than 0.3 A for a rise time of 200 ns and less! To further enhance the overall efficiency one can now use so-called MOSFET drivers specifically designed to perform such tasks. The selected device is from Texas Instruments (UCC37322) and can drive/sink up to 9 A on each gate. This is more than satisfactory. If you don't want to use it, simply connect the controller-IC output to the MOSFET gate directly at the expense of slightly increased losses.

Last, but not least, we arrive at the diode. When using a diode at a forward current of 10A and a forward voltage drop of 0.7V the diode produces 7 watts of heat, which is a 7% loss in a 100W application. To minimize this loss, we can choose low forward voltage Schottky diodes, which are capable of 10A and more. In addition, paralleling diodes will give us some more improvement as the forward voltage is not constant but decreases with lower forward current (I assume that every reader knows the basic I/U curve of a diode). I used the MBR20100CT dual Schottky diode and used two devices in parallel, which gives me four diodes in total. Using this approach also distributes the heat mechanically a little bit to make cooling easier.

We now have discussed the basic losses in a switching regulator. When digging deeper into the subject there are some more things to improve, not only in efficiency but also reliability (remember the catastrophic failure modes?). Those items are partially correlated, i.e., a cool circuit (high

efficiency) will last longer than a hot circuit. This is particularly true for the capacitors used. When one opens a PC power supply it will be seen that in this case bigger is better. This holds for the capacitance, the voltage rating and the size. Larger capacitances will give us less voltage ripple on the output and increased voltage rating allows us to not exceed operating voltage limits. But together with the mechanical size this also gives us an important hint to the equivalent series resistance (ESR) of the cap. When operating at the switching frequency of 100 kHz this equivalent series resistance will degrade the capacitor's performance and together with the ripple currents, will heat up the capacitor. We not only again lose efficiency, but increased temperatures reduce the capacitor lifetime and leads to a potential blow-up (eye-witnessed!). I therefore strongly recommend using low ESR electrolytic capacitors with a temperature rating of 105 deg C (search your preferred suppliers catalogue). When in doubt, select the bigger one as when comparing the sizes of capacitors with same value and voltage rating; the bigger ones have usually lower ESR. This only holds true for modern age devices. Don't try to use the parts sitting in your junk box for 20 years.

To squeeze the very last bit of efficiency from the switching regulator, identify the high-current copper traces of your circuit and solder some copper wires (1.5-2.5 mm²) across them. This will increase their cross section and decrease the resistance, which is certainly significant at the currents we are dealing with.

Circuit Description

After carefully evaluating all of the components, it's time to build the circuit. The schematic is shown in Figure 2. Aside from the already described components, there are some more blocking capacitors for the controller IC, the current sense resistor, the slope compensation and the voltage divider for setting the output voltage. The latter one can be calculated easily by:

$$V_{out} = ((R_6 + R_7) / R_7) * 1.25V.$$

Selecting R1=2.2 kohm and R2 = 47 kohm, this gives us almost exactly 28V. The current sense resistors are calculated with the formula given in the datasheet as 0.006 ohm, which is implemented as three 0.02 ohm resistors (SMD 2512 case). The slope compensation counteracts an inherent instability of this type of topology. While I won't describe the mechanism here in detail (see datasheet for an explanation), this instability results in decreased efficiency and a high-pitched sound emitted by the circuit, although the more "experienced" hams

won't hear it anymore. While this sound may be known to many of us as "normal" for switching regulators, surprisingly our design is completely silent when operating properly.

The PCB layout can be seen in Figure 3 (top) and Figure 4 (bottom). The material used is standard FR4, 89x56 mm, 1.6 mm thick with 35 mm thick copper. Note the close proximity of the power devices. While this is not exactly an HF application, short traces are also important here due to the high currents involved.

A common problem when using switching regulators in a ham radio environment is the switching frequency, which is radiated over the supply lines. To make the regulator "silent", we used a metal box and inserted two little separate chambers for the input and output where some low pass filtering is performed. The needed high-current inductors were taken out of an old PC power supply. The high frequency performance is not so important here for the main inductor, as the basic component at the input/output lines is the DC current. Feed-throughs into all chambers are 3x 1nF feed-through caps.

Results

Two units have been built so far by the author and a third by Charles Suckling, G3WDG. To test the behavior under load the author used high power resistors. With the enhanced high-current traces and the gate driver, 93 % efficiency could be verified at 4.58A output current. This is equivalent to an output power of 128W and an input power of 138W. The remaining 10 watts is lost mainly in the FET and the diodes, but one also can feel the inductor and the current

sense resistors getting slightly warm. Nevertheless, 10 watts is easily dissipated with a handy heat sink. Testing with the 50W, 23 cm PA kit was done by G3WDG showing good performance of the combination of the two designs. Measurements showed that even without the output power filter, no sidebands are generated within the PA. The filter is recommended to keep your own shack "quiet". The remaining ripple with the filter is about 20 mV peak-peak (Figure 5).

A long duration test was performed by constantly drawing 128W power from the regulator for over 7 minutes and temperatures measured on and in the closed box. With an ambient temperature of 20 deg C, the location just outside the MOSFETs heated to about 30 deg C and the inside air temperature to about 40 deg C. The load resistors definitely were warmer.

Conclusion

I have presented a high power, high performance switching regulator circuit designed for 12V use with modern 28V LDMOS power amplifier kits. The overall efficiency is > 90 % at > 100W regulated power. As far as possible, standard market components were used. Tests were performed with artificial loads as well as with a 23 cm PA.

Acknowledgements

I would like to thank first of all Charlie, G3WDG, for the nice 23 cm PA design without which I probably would have never start designing this power supply. He also was beta tester for the circuit. I further would like to thank Coilcraft, Texas Instruments

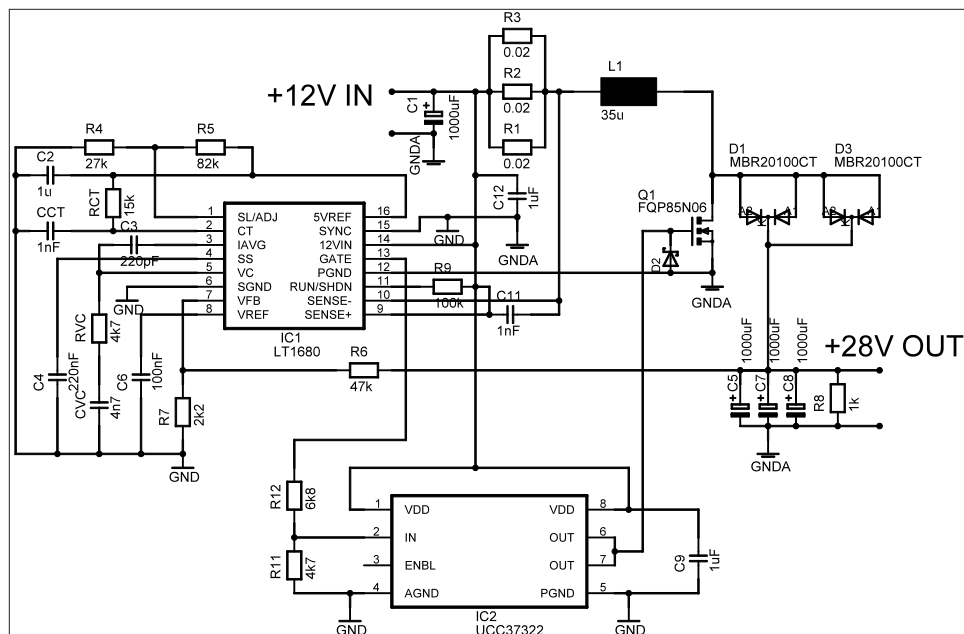


Figure 2
Switching power supply schematic

and Fairchild for supplying samples.

Literature

[1] Carl Nelson, LT1070 Design Manual, Application Note 19, www.linear.com



Approximate full scale PCB patterns are available in PDF format by sending an e-mail to journal@amsat.org

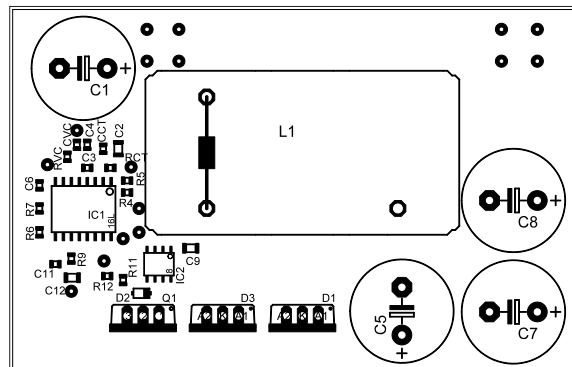
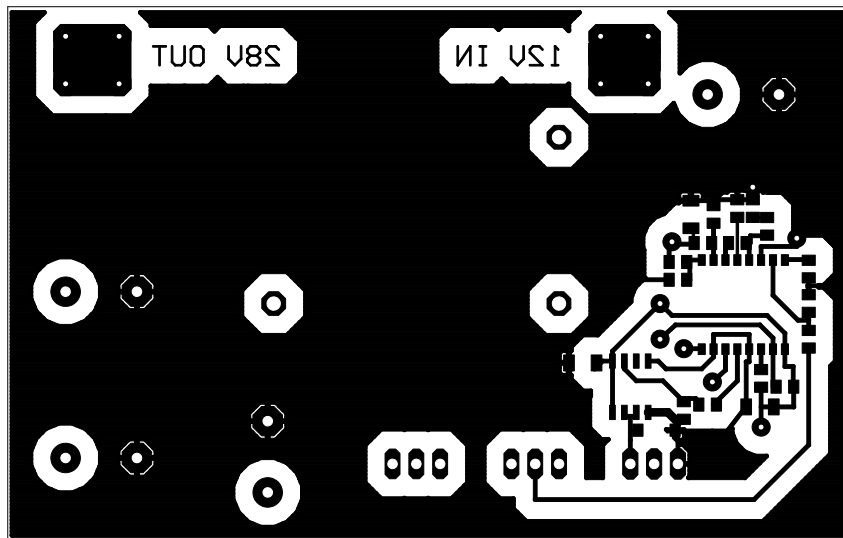


Figure 3
Top side Printed Wiring Board and component layout

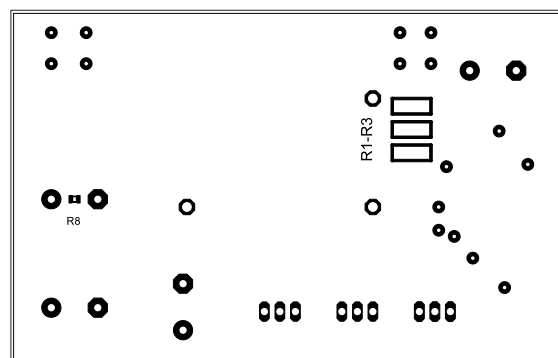
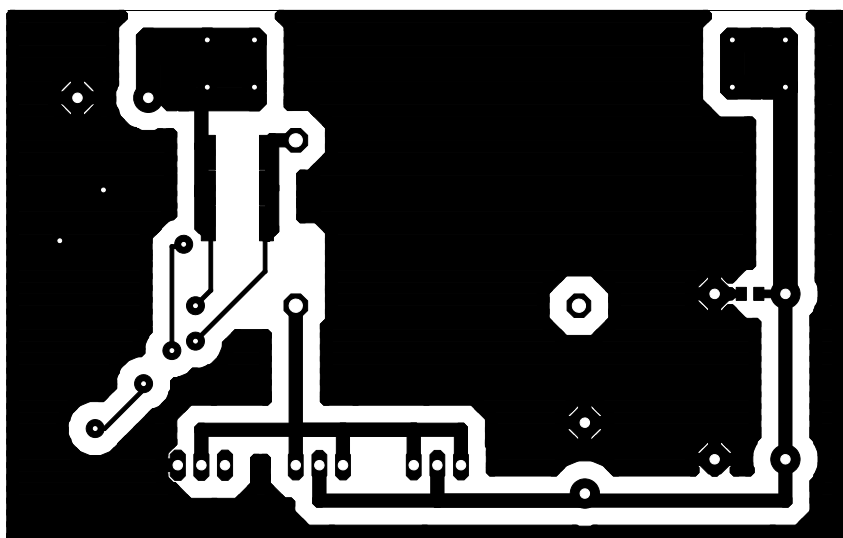


Figure 4
Bottom side Printed Wiring Board and component layout

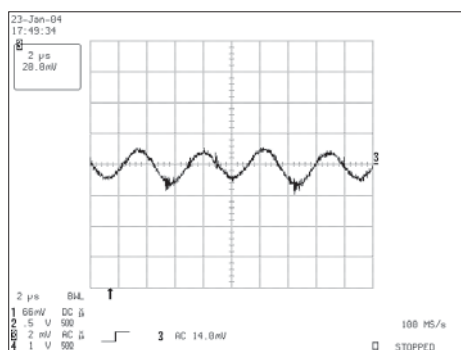


Figure 5
Output ripple content
horizontal: 2 μ s/div, vertical: 20 mV/div



Figure 6
Completed Printed Wiring Board Assembly

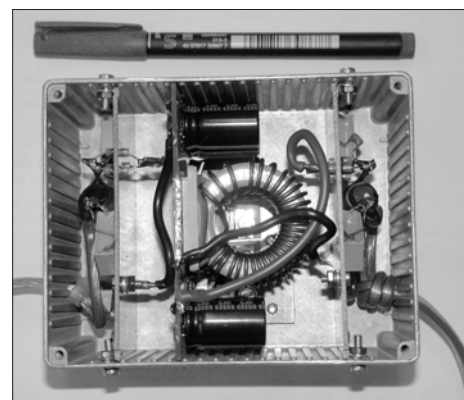


Figure 7
Printed Wiring Board Assembly and its enclosure showing the input and output filters.



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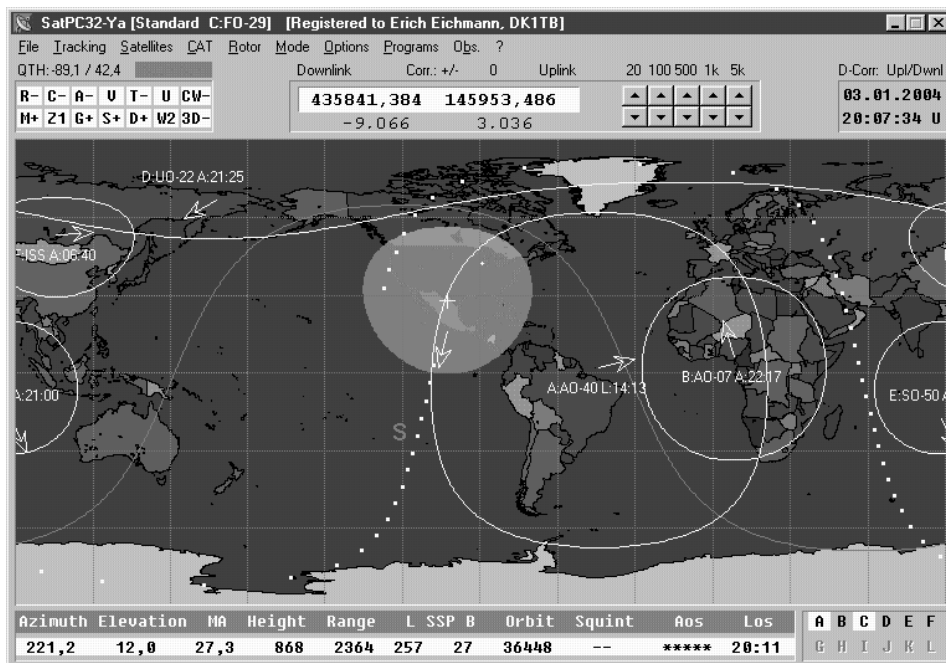
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Report of the AMSAT Board of Director's Meeting

Held October 19 and 20, 2003 in Toronto, Ontario, Canada

Retiring Members of the Board of Directors in attendance were:

Dick Daniels, W4PUJ
Bill Tynan, W3XO

Members of the Board of Directors in attendance were:

Barry Baines, WD4ASW
Tom Clark, W3IWI

Gunther Meisse, W8GSM
Robin Haighton, VE3FRH

Rick Hambly, W2GPS
Lou McFadin, W5DID

Lee McLamb, KU4OS-Alternate

Others participating or observing at various times included:

Frank Bauer, KA3HDO, Human Spaceflight

Art Feller, W4ART, Treasurer

Jim Heck, G3WGM, Hon. Secretary/Treasurer, AMSAT UK

Perry Klein, W3PK, Founding President and VP, Govt. Liaison

Martha Saragovitz, Corporate Secretary and Office Manager

Graham Shirville, G3VZV, IARU Reg. I Sat. Coord., AMSAT-UK

Ray Soifer, W2RS
Steven Diggs, W4EPI

Tim Salo, AB0DO
Nick Pugh, K5QXJ

Drew Glasbrenner, KO4MA

The following Board members also hold the offices indicated:

Barry Baines, WD4ASW, VP, Field Operations

Tom Clark, W3IWI, President Emeritus

Rick Hambly, W2GPS, Executive VP

Robin Haighton, VE3FRH, President & Canadian Liaison

Lou McFadin, W5DID, Orlando Lab Manager

Lee McLamb, KU4OS, Senior Editor, AMSAT News Service

Retiring Chairman Bill Tynan convened a meeting of the AMSAT Board of Directors at 1306 EDT on Sunday, October 19, 2003 at the Toronto Airport Marriott Hotel.

The Question of Whether to Elect a Chairman

The first order of business was to determine if the Board wanted to elect a Chairman.

President Haighton began the discussion by stating that for the last 5 years the Board has had a Chairman after Executive Vice President Keith Baker requested Tynan to serve in that capacity. Prior to that there was no Chairman and the President ran the meetings. Haighton opined that if a decision is made to continue having a Chairman, then the selection should make "very much in conjunction with the President because it is essential in a well-run organization that the President be in complete harmony with the Board". He reminded that there is no provision for a Chairman in the Bylaws or Articles of Incorporation. He suggested that a Chairman is not needed at the present time.

Baines declared that while he appreciated Haighton's position, things have changed in recent years wherein the Board should take a careful look as to its role and function. He suggested that a Chairman would be helpful in the following ways. First, the Board's responsibility is to deal with strategic issues that don't

necessarily involve day-to-day tactical issues. The President is extremely busy working on behalf of the Board to handle these operations whereas a Chairman could focus on Board-level strategic issues. Second, from an organizational perspective, there is concern about having the President, who is appointed by the Board and responsible to the Board, also be responsible for the Board's conduct. Baines thought it appropriate to maintain those distinct responsibilities and not have the President run both the Board and the Corporation on behalf of the Board.

Hambly reminded that he and Soifer had and earlier made somewhat differently worded suggestions that the Bylaws be changed to include the office of Chairman. Because there were inconsistencies between the two submittals, Hambly asked that both be removed from consideration at this time. On the issue of whether the Board should have a Chairman, he stated that Haighton's comments were well taken, but noted that there is no requirement that the President be a member of the Board. Hambly proceeded to express that having the Board led under any title by someone who is not a member of the Board is not appropriate. Hambly advised that there presently are candidates who would run for the position of Chairman. Hambly then recommended that the focus be on considering who is to lead the meetings for the next 12 months.

McFadin agreed with Hambly and offered that he did not perceive a conflict, as the Chairman position does not necessarily confer any powers outside of the Board meetings. Hambly replied that in his experience the Board has routinely made decisions, assigned tasks and created lists of tasks to be accomplished. But, after the meeting there was very little follow-up. We could use a leader who continued to work on those issues and make sure that the things the Board has decided to do actually got done. Meisse offered that the function of the Board is to set policy and to set the direction of the executive branch that it is made up of the President and the other officers. He added, "He cannot fathom a board without a Chairman". Baines observed that the Chairman position is a creation of the Board for its own purpose, to serve in its own way, so you have complete flexibility.

Clark announced that he and some others have been agonizing over this situation and that he can see both sides of the argument. He agreed with Baines and Meisse that AMSAT needs to be forced to think more about the long run and to make a series of strategic decisions. He concurred with Haighton that there is no reason to elect a Chairman at this time because a committee doesn't need to have one, although it might be a good idea.

Clark moved that the issue of a Chairman be tabled and revisited at a later time. Haighton seconded and the Board members voted 3 for and 3 against the motion.

Discussion followed including the suggestion that absent Board member Bruce Paige be telephoned and asked to vote. Tynan stated that he did not feel this would be necessary since the tie vote indicates the sharp division among the Board members and that it would not be in the best interests of the organization to attempt to resolve the situation when such a situation exists. Hearing no further comments, Tynan then asked Haighton to assume conduct of the meeting.

Election of Officers

President Haighton requested that Tynan conduct the election of officers. Tynan first asked for nominations for the office of AMSAT President. Clark, nominated Robin Haighton. The nomination was accepted, and Haighton was elected by a unanimous vote. Haighton then nominated Rick Hambly for the office of Executive Vice President whereupon he was elected by a

unanimous vote. Haighton nominated Martha Saragovitz as Secretary and the vote in favor was unanimous. Clark nominated Art Feller to retain his office as Treasurer and Feller was reelected by a unanimous vote. For VP Engineering, Haighton nominated Stan Wood. The vote in favor of Wood was unanimous. For the position of VP Operations, Stacey Mills was nominated. The vote in favor of Mills was unanimous.

McFadin asked if the title of that office could be changed to VP, Flight Operations and Tynan replied that the title was specified in the Bylaws. Haighton, granting that it might be better defined as VP Flight Operations in the next revision of the Bylaws. Tynan reminded that this was the original meaning of VP Operations.

Haighton reminded that one person may hold more than one office whereupon he nominated Martha Saragovitz to be Manager. Martha was elected without opposition and the election was declared closed.

Board Member's Responsibilities

Haighton explained the purpose of this agenda item is to provide a reminder to both previous and new Board members that in general, whatever goes on at these meetings is transmitted to the members in the form of Reports published in the Journal. It is important to make certain that whatever goes out of the meeting is a proper record of what transpired. Although a Board member may deny it with a comment made before or after, what is said publicly is frequently considered by those listening to be Board policy. He recommended being very careful discussing AMSAT policy when giving talks. He reminded that failure to do this has caused problems in the past.

Clark mentioned an incident that occurred about 18 months ago when a contract was signed between AMSAT and a vendor and the Board was not made privy to the contents of that contract because there was a non-disclosure agreement (NDA) between AMSAT and the vendor. He recommended that for matters like this the Board should have a specific NDA policy stating that certain items can be embargoed and not released to the public. There have been several times when, in order to make a contract, the Board needed to know all the details in that contract and yet the industry did not want those details made public. Haighton agreed, explaining that while Clark had admonished him for this, in actual fact, the Board knew the basis of this action otherwise he would not have done it. Haighton stated that Clark's point was well taken and that they will certainly get a NDA policy done.

Hambly announced that it was timely for Clark to mention this since he had just executed in the name of AMSAT a NDA with an unnamed agency about which exciting information will be disclosed to the Board the following day in closed session. He asked that everyone who is not a Board member who becomes involved in this activity sign a short statement saying that they have received a copy of the NDA that AMSAT executed, they understand it and will abide by it. Hambly said he would provide the statement. Meisse commented that there is a responsibility that the Board has with respect to such contracts. He encouraged Hambly to put together the document now "because you're not going to be signing contracts that I don't know about or I'm out of here because it's a massively libelous situation, so get your document written up and spread around and then in a closed session we'll talk about those contracts". Haighton declared that Hambly had kept him fully informed. He then engaged Feller and a lawyer. Eventually, Hambly was advised to sign as a member of the Board and as Executive Vice President because he is a citizen of the U.S.A. Hambly added that the



NDA only says we intend to have conversations about possible future relationships. McFadin said it is important that there not be an agreement of which Board members are not aware. McFadin maintained that a non-disclosure agreement is one thing and a contract that obligates the organization for money is another. McFadin also noted that we have a responsibility to keep the membership informed of Board actions. Meisse maintained, "that in this day and age a Board must be able to see anything the business does ... but historically we have asked questions and not gotten answers".

Presentation of the 2004 Budget

The Treasurer was then asked to present a draft version of the 2004 Budget. Feller said this had been distributed. It first shows the income projections that according to the Bylaws must come from the Treasurer. Second there is the expense budget that is provided by the President. The income figures tend to be understated with the revenue projections based on a constant level of membership with a small increase in dues of \$3 per year. Feller noted that our accountants have warned that our reserves have fallen below one year's operating expenses, which is highly unwise. Haighton announced that this year he had taken the unusual step of reducing the last year's amounts and then asked each officer for their comments. Those comments were then considered and revised amounts given to the Treasurer for adjustment of the Budget.

Haighton noted that the response from former VP, International Affairs, Soifer raised the issue that if AMSAT is invited to participate in the 2004 IARU Region II conference, the proposed budget for International Affairs is likely to be low by \$1000. Soifer offered that the probability of spending the money is two out of three. The Board agreed to include it noting that, if in a few months the money is not needed, it can be taken out of the Budget.

Baines, referring to the Budget, asked for the meaning of the notations under the category of Life Members. Martha explained that replies from life members to a letter written by Tynan led to the creation of two new categories, those who wanted to vote in AMSAT elections but didn't want to receive the *Journal* and those that never responded to the letter. These designations can be changed whenever a Life Member expresses a renewed interest. She noted that many of them donated to the President's Club and other fund raising activities. She remarked that the letters also provide a means for clearing the rolls.

Baines asked if the assumption could be made that the amounts listed for 2004 are typical of recent years? Haighton announced that an expenditure that is partially paid for is the \$100,000 cost for the launch of Echo. This year a \$50,000 payment was made leaving another \$50,000 to be paid next year. To this sum, \$10,000 has been allocated for someone to travel to Russia to comply with ITAR.

Proposals for Future Meeting Sites

Martha announced that Nick Pugh had stated he was willing to arrange a meeting in Louisiana in 2005 if the Board would choose another site for the 2004 meeting. Martha said the group in the Washington, D.C. area definitely wanted to host the meeting in 2004 but could not commit to 2005.

Bauer referred the attendees to his team's printed proposal to host the 2004 Annual General Meeting (AGM) in the D.C. area. He felt encouraged that there is a big team interested and excited in this undertaking. He noted that 2004 is AMSAT's 35th anniversary year and holding the meeting in the DC area is an interesting and appropriate idea because it's where AMSAT started in 1960. He remarked that it was a unique chance to have the AMSAT AGM jointly with an ARISS meeting. Bauer opined that providing an opportunity for the ARISS delegates to interact with some of the AMSAT-NA members would be very beneficial. He declared it is a win-win situation for the two teams and also an opportunity for AMSAT to save some funds avoiding

the need for two trips. Martha and Bob Carpenter have found a nice motel for the meeting, the Crowne Plaza at Crystal City. He said some of the desirable things about Crowne Plaza include easy access to a mall for shopping, restaurants and the Crystal City Metro station that provides access to the entire Washington area. Another activity available for meeting participants is the Smithsonian Air and Space Museum's new Steven Udvar-Hazy facility at Dulles Airport with the Space Shuttle Enterprise, the Concorde and much more.

Baines asked about rates and Martha reported that it was estimated that a hotel room should cost \$90-\$95 per day which is extraordinarily reasonable for the Washington area. Martha also reported that the hotel has agreed to reduce the \$12/day parking fee to \$5 and had made arrangements for outdoor parking to accommodate tall vehicles and antennas.

Hambly then made a motion that the Washington proposal be accepted for the 2004 meeting and Meisse provided a second.

Discussion followed with Baines suggesting that there an advantage to holding the Board meeting before the AGM may be that announcements of Board decisions could be made at the general meeting. With regard to the meeting schedule, Soifer reported that the Bylaws only required that "at this meeting, the President shall present a report to the members". Soifer suggested having the previous President present the report as an option. Haighton declared that he could guarantee that there would be a new President. Bauer offered that the ARISS meeting could be scheduled either before or after the AGM with the qualifier that he would have to get agreement from the ARISS group.

Haighton called for the question and the resulting vote was unanimous in favor.

Bauer offered that, based on what had already been approved, the thing that's needed soon is to know if the Board will meet before or after the AGM. Haighton asked for a consensus on this question. There were 5 votes in favor of holding the Board meeting first with Haighton abstaining.

Martha expressed concern that holding the Board meeting before the AGM would give the appearance that the Board meeting is not really open to the general membership. Baines opined that one measure is people already being in the city but another is being able to communicate with the membership about decisions of the Board. So, having the Board meeting first makes it more open because the results can be publicized more effectively. Feller remarked that meeting with the membership and getting a sense of what they want before the Board meeting is held is more valuable. Haighton asked Bauer to let the group know what will work with the hotel. Haighton explained that he didn't want to lock Bauer into a definite proposal and then find it can't be met.

ARISS Status Report

Bauer referred the Board to his ARISS Program Update handout, the e-mail on the subject and his presentation given the previous day at the Symposium. He mentioned the challenges that the ARISS team faces. He asked that the Board work with him to dispel incorrect perceptions that exist among the membership. AMSAT members should understand that ARISS is an international team and that because of different cultures and expectations the delegates have diverse ideals and opinions. This situation causes him as ARISS Chairman to walk a tightrope and to make certain that all understand that he does not have total allegiance to any one organization. Another aspect is that while he would like to see AMSAT get as much recognition as possible for its role in the program, what the press reports is not entirely within our control. Furthermore, Bauer observed that there have been instances of NASA-bashing on AMSAT-bb which could have a potentially negative affect on our future. We have an opportunity in the future to do new and different things and that

could be lost. He asked that the President assist in this matter. With regard to the IMAX film *Space Station*, he declared that it was difficult to even get the Amateur Radio segment included. It took some last minute activity and Carolyn Conley was instrumental in making that happen. He called attention to the litho that has AMSAT on the back cover. Meisse asked if a small pamphlet about Amateur Radio in space was made available would ARRL agree to include our material? Bauer replied that the material generated for the IMAX premier was the start of something like that. Bauer noted that they would be talking with an individual who hopefully will work with the US representative to the PR committee. The Canadians already have such an individual who is doing a good job. We need one in the US from an AMSAT perspective and it appears that we will have one. Hambly pointed out that among the current action items there is the task of finding someone other than Bauer to promote ARISS with an AMSAT point of view, and that has been a difficult position to fill.

Bauer continued his report by describing ARISS financing. He stated that in 2002, AMSAT budgeted \$38,000 and about that much was spent. So far in 2003 only \$6000 has been spent, the reason for this difference is that only one ARISS meeting is planned this year and so far there have been none. Next year there will be two meetings, one of which will be in the DC area. Another savings resulted from increased ARRL support. There is now a 50/50% travel cost sharing arrangement in effect. The third saving resulted from changes in the NASA travel situation so now on an occasional basis he could use NASA funding to do ARISS travel. For example, on an upcoming trip to Russia, three will be going on NASA funds, two will go on AMSAT and ARRL funds and one will pay his own way. Thus, six from the US are going but AMSAT will pay for only one. He then continued his report describing the contributions received. ARRL's contribution was \$35,000-40,000 and NASA is putting in \$170,000 real dollars per year. An important thing to realize, he said, is that the in-kind contributions made by volunteers around the world have been evaluated at \$5,000,000 per year. The in-kind contributions of the space agencies are also in the millions of dollars. For example, we've had four launches during 2000-2001 and there will be three in 2003-2004, both Russian and US. Furthermore, the Russians led all the EVA activities and were responsible for the feed-thrus. These things that the Russians have provided are worth millions of dollars and the Europeans are doing the same kind of thing. It now looks promising that we might have a feed-thru in the European module. Another cost factor is the astronaut crew time. So, if you add it all up and consider that the Japanese team has obtained numerous YAESU and Kenwood radios to support development and training this year, from an international perspective there is a lot of involvement and investment. McFadin explained that EVAs cost money and having the Russians pay for three is "unbelievable" because the hams have never been able to get an EVA before. Bauer commented that hardware development group is certifying the third phase of the permanent station for flying on the Space Station and noted that AMSAT has not borne the brunt of the hardware costs associated with what is now flying on the ISS. McFadin explained that the most expensive part of flying something on a human space flight is the certification process. Haighton added that as a Canadian ARISS delegate he would contact AMSAT representatives in other countries to ask for donations toward ARISS funding.

Tynan suggested that a team write an article in a wide circulation publication such as *QST* because many among those who make comments on AMSAT-bb are not AMSAT members. Bauer agreed that this was a good suggestion. Hambly declared that one thing that would help stop the bashing is to resume the routine contacts with average hams as was once done. Bauer replied that they are working on the issue and reminded that



any support the astronauts provide is on a volunteer basis. That means if they take 15 minutes to make contacts it has to be out of their sleep period or their personal time. He said his group is working with NASA headquarters to change that philosophy, but there are aspects that make it difficult. Bauer added that part of the problem with the packet module is that it requires that they hook up a computer and it takes time to do that. They could not get Mission Control to provide them with the opportunity to do that because the astronauts have been overburdened with work. He reminded that following the Columbia accident there are only two crewmembers on board instead of three, so they are much busier than they were before. He declared that he has sensitized the NASA community many times about the fact that the packet module has been down.

Bauer commented that the ARRL Web site has shown noticeable improvement in the articles that have come out in the past 4-5 months. He felt that the prior lack of mention was likely due mostly to oversight. Bauer added that he had a lot of respect for *QST* Senior News Editor Rick Lindquist who has done an excellent job of publicizing what was going on. Now you will find every ARISS article mentions AMSAT along with the other US participants, ARRL and NASA. Clark suggested asking the League to help generate external publicity and possibly bring it to the attention of the NASA Public Affairs people as well. Bauer said they were working on these matters too.

Bauer concluded his remarks by referring to the future opportunities for external payloads. He reminded that the Space Station is a satellite and it can fly autonomous external payloads. He recommended holding strategic discussions within AMSAT-NA about where this might go. For example, Shirville has an idea for an ATV-type package and Bob Bruninga has already gone ahead with this kind of thing with PCSat-II. Bauer reminded that in addition to the express pallets there are other opportunities and what is needed is a proposal that can be offered as our idea for a flight. Baines asked Bauer's opinion about an appropriate time-line to say that we are interested? Bauer answered that 2 to 3 years is probably a reasonable number. McFadin suggested coming up with a "Bruninga-like" payload that is simple to build, easy to integrate and inexpensive. Tynan remarked that this might be a marvelous opportunity to fly a Mode-A transponder or something more developmental such as Karn's idea. Bauer said that what is first needed is something in writing to use as a presentation package. McLamb declared that as a new participant at Board meetings he had never seen these kinds of opportunities discussed with the regular membership and that we need to improve on that communication even if all we are looking for is ideas. Hambly observed there are a lot of opportunities although few become real, yet not all are zero. Bruninga's approach is to "just keep beating on the door" and when an opportunity comes along that's real, he's got the hardware almost ready to go and launches it. Bauer stressed that there are organizations wanting to partner with us in the area of human space flight. McFadin opined that an idea needs to be more than just a piece of paper, perhaps a breadboard that can be turned into a piece of flight hardware within a short time. He noted that when NASA asks for the requirements and interfaces, if we say we haven't figured that out yet, they will dismiss the proposal.

Hambly then made a motion for a Sense of the Board resolution thanking Bauer for leading the ARISS program over all these years and for tolerating the many obstacles he's had to put up with to keep going. Meisse seconded and the motion was passed by a unanimous vote.

Recent FCC Rulemaking Proposals

Soifer reviewed existing petitions and accomplishments. In the matter of the Broadband over Power Line (BPL) issue he declared that with the help

of Klein, Tynan and several others, AMSAT had filed a set of comments and reply comments with the FCC that opposes BPL in the strongest language. Soifer stated that there is a parallel proceeding going on in the European Union. Tynan acknowledged Soifer's contributions to framing AMSAT's response, especially from the standpoint of satellite reception while everyone else is looking at it from the view of Amateur Radio in general.

Moving on to other regulatory matters, Soifer reported that in November 2002, AMSAT had filed a request with FCC to change the time requirements for informing the Radio Communications Bureau of prospective launches. Klein reported that he had learned that it had been combined with the omnibus petition for a modification of the amateur rules. The date for releasing that has been delayed until the end of 2003.

Turning to the subject of helping the small satellite community to understand that we want to help them, Hambly said that under FCC rules, to accommodate the universities it would be necessary to relax the ones regarding pecuniary interest. He reminded that they had been relaxed before and we needed an almost identical exception now for people who received salaries or stipends from universities to do command and control. He declared that we also needed to remove the restriction about providing personal communications or advancing the radio art and broaden that to include scientific activities. Feller stated that it is a spectrum policy issue. If we believed that a satellite did not fit in the amateur service it did not say that we shouldn't help them find an appropriate place to go and to give them guidance about frequencies. Hambly disagreed because it sounded like we were chasing them away and that is exactly what he did not want to do. McFadin reported that the universities he worked with are glad to have our input and when he talked to them about amateur vs. scientific applications they went and looked for frequencies that were appropriate, so what they needed was guidance. Klein noted that the FCC did not seem to be overly bothered by this issue. Hambly declared at the previous day's meeting the IARU, as a policy had decided that they might advise a builder that a project may not be appropriate, but they will still coordinate them. Thus, one possible thing AMSAT might do is nothing because advising people on the law or regulations is not our role. Feller protested that this is not what had happened. Hambly explained that this is not his point of view but is one strongly held by some persons.

McFadin asked if we are saying, "AMSAT should encourage the builders to operate on amateur frequencies"? Tynan stated that was his point of view as well as Hambly's. McFadin declared that when he mentored students, if the project is pure science with no apparent provision for amateur communication, he would tell them that it should be done on a frequency appropriate for a science experiment. Tynan recalled that ARRL General Counsel Chris Imlay had pointed out that, with regard to FCC rules, content was not really restricted. Tynan explained that this petition would say flat out that things of a scientific investigative nature were OK on the ham bands. We want those people because we think they are going to help Amateur Radio. Tynan continued, saying that the second point of the petition concerned the matter of pecuniary interest and it dealt with that in the same way the Commission had done in the past in the case of the teacher in the classroom situation and to a lesser extent with WIAW operators.

Baines asked about the status of the petition that had been put together on the subject of frequencies appropriate for scientific experimentation. Haighton replied that the next step would be to send it to the League, and then if their review and comments were favorable it would be filed forthwith. Baines asked if there was a consensus among the Board on the content of these petitions?

Tynan noted that we are the only satellite service that does not require prior licensing by the FCC. Although the FCC cannot control launches, they do have the authority to say what may be put into operation once up there. AMSAT had participated in developing that NLI and the prelicensing of amateur satellites would assist them in whatever action they eventually take. Hambly asked why the FCC stopped licensing amateur satellites? Tynan replied that it is part of deregulation and they did the same thing with repeaters. Hambly asked if this petition had been run past the ARRL? Tynan replied "yes" and he noted that Imlay's response was more positive than to the other proposal and that he also commented that this action might increase the status of amateur satellites if they are licensed.

Baines asked if, when a petition is drafted, had there been prior agreement made that this is something the Board as a whole wanted to do, or does the petition wait for Board approval? Haighton replied that in general they had not asked for approval of petitions because they knew the general policies of the Board. Haighton asserted that if one-by-one Board approval were required, we wouldn't be responsive enough. His answer to Baines' question therefore was "No". Baines expressed his concern that when you approach outside organizations they would assume that the Board had already agreed. He declared that he sees a dichotomy in that we are working on a draft petition that proposed a change in the rules while at the same time a white paper was being assembled that addressed the very same issue. Hambly stated that getting unofficial feedback from FCC personnel is a good way of getting input to our strategic initiative in this area. Feller stated that he thought it first necessary for the Board to agree in principle that this is an idea they ought to pursue. Hambly predicted that just submitting this petition would provide an immediate improvement in our relationships with the university community. Tynan reported that he had mentioned the proposed petition to Twiggs who is very much in favor of it.

Hambly summarized that after ARRL feedback had been received and considered it would be taken to the FCC privately for an opinion. Hambly continued, saying, then at that point the petitions will come back to the Board for a resolution regarding filing. Feller recommended thinking about the long-term future effects if we have a change in policy.

Baines declared that Tynan and Klein should be thanked for the work they had done. Haighton added that Soifer and King had done a tremendous amount of work on this over the past year as well.

Progress on ITAR Matters

Klein explained that the term ITAR referred to the International Trade in Arms Regulations and reported that progress on matters affecting AMSAT had been slower than expected.

Haighton explained that the additional \$10,000 he had added to the Budget for the launch of Echo is to help AMSAT conform to the ITAR rule that, when out of the US, a spacecraft must be kept in the presence of a US citizen at all times. Daniels explained that because SpaceQuest had previously flown satellites on a Dneper vehicle they had the process worked out. Hambly asked if the Russians are satisfied and Daniels replied that as far as he knew they were, although there is still the requirement that a State Department letter must be sent. He opined that there is every indication that this is on the fast track.

Status of Various Previously Presented Fundraising Initiatives

A. Selling Donated Equipment on eBay

The proposal submitted earlier by absentee Director, Bruce Paige, was introduced. Haighton asked for comments and McFadin described a bad experience he'd had with PayPal. McFadin clarified that he is not against selling things on eBay, he was just cautioning about using PayPal. Martha recommended that we



encourage people to make a donation if they sell their equipment. She mentioned that this has happened before and AMSAT did receive the money. McLamb opined that it would be important to have someone from the organization doing the posting if it's done under AMSAT's name to ensure the descriptions are fair and that shipping is handled promptly. Haighton reported that both Paige and Glasbrenner have agreed to act as shipping and posting agents. Clark thought using the AMSAT name would be good advertising and commented that selling donated equipment on eBay has the added advantage for a donor in that they can claim the entire cost, including shipping costs, as the certified market value for their tax return.

Baines declared that the issue is whether or not the Board approves the placing of AMSAT's name on an eBay posting and so they should decide on that and defer the issues of implementation. Meisse remarked that this is really the question.

McFadin moved that AMSAT will proceed with this and the details will be worked out. Clark seconded and the motion passed with no dissenting votes. Feller requested that he be advised through the office as to what has been worked out. Clark added that the Board should be informed about the procedures being used so that they could promote it.

B. Flying Commercial/Scientific/Educational Payloads on AMSAT Satellites

Hambly announced that he had little to say then on this subject because the most productive things he can report must be said in confidence. He revealed, however, that he is still negotiating with a national laboratory for the possible construction by AMSAT of a satellite to support ionospheric research and similar studies. He noted that Clark had spent considerable time discussing the merits of the experiment with the physicist involved. The conclusion was that regardless of the experiment's results, AMSAT would get a free satellite. Hambly asked if there is an issue carrying a pure science payload if the remainder of the satellite is AMSAT's? Baines inquired about spacecraft details and Hambly replied that it would be similar to Echo so we would likely go back to SpaceQuest to have them build another microsat with the proposed experiment in place of the L/S transponder. There may be other differences needed to accomplish the mission, but it would be a derivative of what we are doing now.

C. Potential Fundraising Strategies from Sources Outside of the Membership

Meisse distributed a printed version of his plan for raising funds. He suggested that the Board members look carefully at the long term financing of the organization, not the short term. He emphasized that this is not a substitute for the President's Club or any other fundraising effort in the next two or three years. He stated that AMSAT has to continue its membership and launch campaigns to sustain the organization for a few years. He said that his is a long-term attempt to put a public face on AMSAT. Meisse declared that when entering the field of public (not government) money you are expected to have a specific appearance. A basic prerequisite is to have a supply of annual reports, which AMSAT doesn't have. These tell the foundations exactly who is our constituency. Part of that constituency needs to be defined through a member profile. The profile will be a demographic and economic profile of about four hundred members done at random from the membership database. The non-responders would then be queried by telephone. He said that the survey would be comprised of two things, first a set of facts based on the demographics and second, an opinion set to get some sense about what our membership thinks about LEOs, HEOs, SSB, FM and digital transponders etc.

The next effort would be the development of a case for support. It would be a fairly substantial document of 40-50 pages. It would look at the concept of AMSAT, its history, what it is today and what it aims to be in the

future. When it's done a reader will understand the AMSAT story, its educational and hobby aspects.

The next thing Meisse proposed was to establish an endowment fund. He said that the money residing in an endowment fund will belong 100 per cent to AMSAT and it was controlled and dispersed totally by the Board of Directors. He explained that it is a place to put money that has an acknowledged structure and a set of policies that have been endorsed by the Board regarding how the fund will be run. Meisse declared that he had an experienced legal counsel in his town that had agreed to do the paperwork required for which he would pay the cost. He asserted that foundations prefer to give money to similar tax-exempt organizations having an endowment fund. He stated that his experience had shown that this outlook is relevant.

Haighton read the following motion that had been proposed by Meisse. "Be it resolved that the Board of Directors of AMSAT-NA hereby authorizes the establishment of an AMSAT Endowment Fund. Such fund shall be formed for the explicit purpose of establishing and directing the structure for the solicitation of funds and gifts and such other fundraising projects as are permitted under federal law. Such monies are to be used for the works of AMSAT-NA". Hambly seconded the motion.

Soifer asked if a separate corporation was being proposed, i.e., a foundation, or is this simply a fund to be administered by AMSAT-NA? Meisse stated that because we are a 501(c)3 organization another corporation is not needed. Feller then asked if there were other costs in setting up the fund? Meisse's reply was that it would be initially only for film for the Annual Report. He added however, that the costs associated with things like printing the Annual Report in 4 colors on heavy stock will become an issue because we want it to be a substantial piece of work and it won't be cheap to print. Martha commented that this is something we need to try. Meisse stated that he would pay to have the first few hundred printed. Haighton reported that he had asked Meisse to assume responsibility for running this aspect of the plan for the first year. Haighton then strongly suggested that the Board ask Meisse to go forward with this. Haighton recommended that he, Meisse and VP Development Wittenberg get together for a discussion of the plan.

Haighton then called for the question. The resulting vote was 6 to 0 in favor of the motion.

Haighton then directed the Board's attention to Meisse's second paragraph and opined that this paragraph just needed understanding and implementation. Baines asked who would select the committee members? Haighton replied that he and Meisse would do that in conjunction with anyone on the Board who expressed interest. Meisse stated that he would complete his part in 45 days and let the others carry on.

Clark reported that he had received a telephone call from AMSAT VP for Development Wittenberg to report progress in raising money from grants, etc. Wittenberg stated that the status of giving by local civic foundations in 2003 was described as "horrendous" and contributions from state and federal assistance programs is also "way down". His conclusion was that AMSAT is in as good a shape, if not better, than most other organizations seeking contributions. Martha reported that articles appearing in the *New York Times* and the *Washington Post* had provided the same information.

Membership

Feller passed around an AMSAT advertisement that ran in *CQ-VHF* and noted that he hoped that it would also run in *QST* in a color version. The idea of the ad was, that in addition to the President's Club, which has turned out to be quite successful, there would be a QRO (high power) level of membership for \$50 that offered as a premium either *InstantTrak* software or a set of CD-ROMs containing past issues of *The AMSAT Journal*. The next step would be to ask for \$75 and \$100

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Uplink Interference - continued from page 11

TG-P-04), calling attention to the growing problem of intruders in the VHF and UHF bands. Most recently, the IARU Region 1 Monitoring System has undertaken to include VHF/UHF intruder problems in their regular activities.

To respond better to this problem in Region 2, the general procedures of the Monitoring System will be broadened slightly, resulting in three small changes:

1. Member societies in Region 2 are encouraged to include the VHF/UHF bands in their monitoring system activities, especially, but not only, the amateur satellite uplink sub-bands;
2. Societies are encouraged to include reports of intruders in the VHF/UHF bands in their monthly reports to the IARU Region 2 Monitoring System Coordinator; and;
3. When monitors or coordinators report intrusions involving satellites, they should also send a copy of their report to the IARU amateur satellite Advisor, ZS6AKV.

These changes can be seen in context in the Web pages at:

<http://www.storm.ca/~iarumsr2/index.html>
<http://www.storm.ca/~iarumsr2/vhfuhf.html>
<http://www.storm.ca/~iarumsr2/report.html>

I hope that your organization will support and promote these changes. Thank you and I wish you success in all of your work.

Very 73,
Martin, VE3OAT
Martin H. Potter, VE3OAT
IARU Region 2 Monitoring System
Coordinator



amounts. He cited trials of this plan carried out at several hamfests including Dayton, where it worked out reasonably well. Feller stated that he'd like to receive an indication from the Board to proceed. Meisse suggested adding a \$200 level. Feller remarked that he had discussed the plan at length with Martha and if this plan becomes a success it will permit a more modest dues increase and would yield approximately \$14,000 more income. He added that this amount had already been included in the draft Budget. He contended that a \$3 increase in dues would not cause a loss of members but, as Clark had noted, hams are notoriously frugal. Martha reported that it had been about three years since the last dues increase. She remarked that VP Strategic Planning Bill Burden had suggested a one-year delay. Her suggestion was to wait until Echo is successfully launched. Soifer added to Martha's comment that AMSAT had also become in many people's minds an organization of broken promises. He maintained that this lack of credibility makes it difficult to propose dues increases. Hambly pointed out that the increase is needed before the Dayton Hamvention. Feller recommended keeping in mind the technicalities of the increasing costs of various things such as rent, postage, etc., and he explained that it is part of the escalating cost of living. He added that it will make a big difference in our budget and effecting a modest dues increase is a responsible thing while failing to enact an increase would be irresponsible. Feller noted that an additional line item in the Budget will be needed to cover the cost of the premiums. He estimated that amount to be \$2000.

Martha asked for an opinion from Heck and Shirville if \$50 would be an unreasonable amount for those overseas? Shirville opined that it may be better to wait to see if Echo goes before raising the dues so that the rates could be increased more than those just proposed. Martha added that because she is frequently in contact with members she knows that a large percentage are elderly and living on a fixed income and may be lost when dues are increased. Baines declared that the membership dues must be at the level required to sustain the ongoing daily operations required to support the membership, but the money needed for projects will have to come from beyond the dues.

Feller summarized the proposed dues structure as US \$39/year, Canadian and Mexican \$45/year, foreign \$50/year, societies \$75/year and Life Members 20 times the annual dues rate. Clark made the motion to adopt the rates that Feller had proposed. Hambly provided a second and the vote in favor was unanimous. Clark then moved to specify that the family rate be 1.5 times that of an individual's dues and that the second member would not receive a copy of the *Journal*. Hambly seconded and the motion passed without dissent. Haighton said that the increase in dues would be effective on January 1, 2004. Haighton continued saying that at that time there would also be a range of additional amounts established to receive premiums.

Feller then displayed some stickers and artwork to improve AMSAT's marketing. He then asked for Board approval to have the AMSAT office carry out this and other ideas to increase income. Haighton declared that he was in favor of supporting Feller's request and suggested that the President and Executive VP be kept informed.

Clark declared that the most critical factor is the fact that there are now just 2600 dues paying members. Martha corrected to say that there were approximately 4000 such members. Clark continued, saying that we know the identity of at least 10,000 former members who had drifted away for various reasons. He declared that this resource needed to be tapped and that a significant campaign was required to ask why they left and if they were still interested? He stated that another resource that hadn't been tapped was those persons who were not members although they subscribed to the mail lists in order to obtain orbital elements, etc. He declared that these were two groups of prime candidates to

receive solicitations. Meisse agreed that Clark's comments were "right on the money" and a hard look at the services that are going to non-members is needed. He opined that if those people want the things that we provide they ought to be members. Clark reminded that the Web site and AMSAT-bb serve the international AMSAT community and a significant fraction of the users of these services are members of other AMSAT organizations who should not be excluded. Meisse speculated that if our database as well as the databases of the other AMSATs were upgraded to a more Internet-useable format, it would not be difficult to allow access for their members.

Klein reported that at the most recent ARRL-AMSAT meeting AMSAT had suggested that the ARRL representatives convey back to Newington the suggestion to establish a combined ARRL-AMSAT membership. Haighton replied that he had been talking with ARRL about this and nothing had been arranged and added that he'd rather not discuss this subject at that time. Baines suggested also talking to the Radio Amateurs of Canada (RAC) organization about that sort of thing and Haighton replied that he had not done that.

IARU Satellite Meeting Report

Soifer reported that the progress made by IARU Satellite Advisor Van de Groenendaal and the Advisory Panel in starting the new IARU frequency coordination scheme is summarized as becoming operational after a period of gestation.

Soifer announced that they had completed a revised Request for Frequency Coordination form plus a newly revised Amateur Radio Satellite paper reflecting all the changes made at WARC'03 plus a database that will be frequently updated with all the coordination requests received and their status. The coordination process will then be fully transparent, not only to those who filed such requests, but to everyone else. Van de Groenendaal had mentioned at the IARU meeting that the satellite group needed AMSAT's support on a continuing basis, because they will be encouraging prospective satellite builders to come to AMSAT first, and they will also be coming back to AMSAT and ARRL asking for help with US and Canadian issues. Soifer said the Committee will need AMSAT's help through ANS, AMSAT publications etc. as well the support of AMSAT executives and officers. He added there had also been a suggestion that something might be done at the Small Satellite Conference where a representative from AMSAT usually attends. Klein suggested that it would be helpful to make IARU information more easily found on the AMSAT Web site.

Feller reported that at the IARU meeting they had revised the paper that described Amateur Radio satellites and what they did. It listed other places in the spectrum that non-ham satellites could operate. The university groups were finally beginning to read that, so there is a way to provide the needed frequency management education.

ANS and Publication Report

McLamb stated that while there had been a lack of information available to Board members and officers about how to submit items to ANS, it has since been provided. Clark maintained that the address to submit material is still not widely known and is difficult to find. McLamb advised that he would add the editor's e-mail address and a request for material to the opening paragraph of the ANS weekly bulletin. McLamb continued his report stating that after the IARU meeting he had given Van de Groenendaal the ANS editor's e-mail address for IARU news items. He declared that he'd like to receive more submissions to keep members advised of all the things going on within AMSAT. He stated that the more we tell the members about what we are doing the more they will perceive that their membership is valuable. He opined that some of the approximately 3000 subscribers to ANS are former members and if they start seeing exciting things happening they might return.

Meisse asserted that the ANS format should be made more attractive. Haighton informed him that about 8 months earlier he had challenged the policy of distributing ANS in plain text. The result was a deluge of responses replying that it was needed. Clark reminded that ANS historically has been formatted for packet radio transmission and that in Europe ANS still circulates via packet. Also, brevity is important in those places where they pay for an e-mail connection by the minute. Haighton repeated that he had received more than 300 replies asking that ANS be kept in plain text for distribution in places like Hong Kong, Thailand, India, Europe, North and South America.

Field Operations Report

Baines announced that he had distributed the Field Ops Report and he would only summarize the content. 1) There had been a small increase in the number of Area Coordinators. 2) The Field Ops Breakfast went very well and there had been positive feedback from the attendees. 3) A beta version of the revised Area Coordinators Toolkit [CD-ROM] was distributed with a request for comments before a final version is distributed. 4) A one-page handout of Echo information will be prepared so that Coordinators will have it available when they make presentations. 5) At hamfests the benefits of AMSAT membership will be promoted to help generate revenue. 6) The Coordinators will be encouraged to find additional hamfests where they can promote AMSAT. 7) Additional information will be included in the Toolkit, e.g., how to work SO-50. 8) An updated list of AMSAT's experts to contact when further information on a subject is needed. Hambly stated that he had been encouraged by what he had seen and heard at the Field Ops Breakfast.

With regard to the 2004 Dayton Hamvention, planning was underway and a committee would be formed to work on the set up.

Baines declared that one of his concerns is the launch campaign and how the Area Coordinators could help in fundraising, such as by asking for contributions when making a presentation before a club. Haighton declared that a volunteer is needed to serve as chairperson for the launch campaign. Martha opined that a PR type person is needed for this job and she advised that care must be taken about who is chosen because in the past we have given that kind of work to the wrong person and nothing got done.

AMSAT Internet Facility and Electronic Publishing Report

Haighton reported that he had received nothing from VP, Electronic Publications, Paul Williamson. Hambly began by declaring that the Web site needed a great deal of thought and work so the executives will begin on that process as soon as possible. Haighton declared that the problems are both personal and technical and we have to solve both of them. Martha asked that the Shopping Cart be made separate from the Web site.

Meisse asked for comment on the concept of having a closed portion of the Web site. The home page would in essence send a message to encourage joining AMSAT and it would stress the advantages having access to the closed portion of the site. Meisse's criticism of AMSAT's site was that it is "graphically horrible" and difficult to maneuver through. Hambly pointed out that the problem is much bigger than just the Web site as it also involves access to the membership database. We may also have to consider rehosting the site because the current host would not support "commercial" services. Hambly also noted there is a need for systems designers, experts in human factors, particularly those relating to the office and also with some aspects of the Web site. Martha suggested putting out a call for help. Feller remarked that it might help if we collaborated with our sister AMSAT societies to produce a worldwide database that would allow us to do things like exchanging each other's products, etc. He opined that because it is the same task there is no sense in repeating it several times over. Hambly agreed that



internationalization of the problem might help us solve it better.

McFadin stated that he'd like to see the e-mail forwarding privileges limited to members. Hambly provided a counter suggestion, stating we could send non-members a solicitation message, like the QRZ site, suggesting that the user consider becoming a member. Clark suggested that a message in the signature block for nonmembers encouraging them to become an AMSAT member could be used. Haighton suggested that Hambly handle this matter.

Outlook for Future Satellites

A. Eagle

Haighton announced that he had received no information about Eagle from Stan Wood.

Hambly announced that there is work being done on Eagle. People dedicated to getting Eagle into orbit are continuing to do things that don't cost money. He opined that AMSAT had presented the wrong impression when it came to how the information about the Eagle budget cut was presented. Nevertheless, some individuals kept on working and he has just learned of a Junior College in California where the students are going to build the boxes that hold the RF components. They volunteered the time and materials to do this and Jansson had been very careful to make certain the material specifications were known before construction began. The school plans to provide two of each of the four size boxes. He would soon be recruiting some RF designers to start building circuit boards. Notably, this is all being done with no money and no budget. Baines asked what university is building the Eagle RF enclosures? McFadin said that it is the Santa Rosa Junior College, the same team that had built the earth sensors.

Haighton inquired about design discussed at the Denver meeting in 2002. Hambly replied that the configuration had been changed in the subsequent Orlando design meeting but the minutes and documentation from that meeting have not been delivered. This is a problem that needs intervention by the President. To get designers of various types fired up about Eagle, Hambly promised that he would publish an Eagle article in the Journal. He declared that the Eagle architecture needed rethinking in light of P3E. Hambly declared that Project Committee members who are working on the architecture should get together again to talk about these things. McLamb reminded that when Eagle was first announced it was stated that it would be an open project. However, when design meetings were held in Denver and Orlando only a few persons knew about them. He opined that to get the next generation of designers involved these meetings must be announced in advance so that people can attend.

Hambly agreed that at Denver it was decided that Eagle would be an open design to the extent that is possible although there are some policy issues that deal with ownership. Our historical approach had been that AMSAT does not own the designs, the designers do and they could choose whether or not what they designed is going to be open. Feller pointed out that there is an agreement stating that the creator owns everything. He continued that the Board should decide how to handle this policy. Hambly noted that among our community of designers there were strong feelings and different opinions. Meisse asked if there is room for an agreement with developers that permits them, maybe by default, to maintain an intellectual license to their designs but grants us unlimited use? Feller expressed concern about the need to secure rights for AMSAT when somebody works with us as a volunteer, and particularly when we have an investment, to make certain that our participation in those intellectual property rights is secure. Clark reminded that our Bylaws stated that all intellectual property is the property of the person who creates it. AMSAT owns nothing unless it is intentionally given over.

Meisse asked that the record show that it was *AutoDesk Inventor* that Jansson used to design the Eagle structure.

B. Echo

Hambly announced that Echo is nearing the end of its construction period and integration would begin in early December with a launch in the spring of 2004.

Daniels said that we were in good shape on Echo's budget having paid off everything we owed with the exception of the \$7500 set aside for the digital voice recorder (DVR). Haighton stated his belief that the invoices for the DVR had been paid. Daniels said this is fine but it revealed that our accounting system had problems tracking project costs adequately. Martha did not fully agree. Haighton reminded Daniels that at the beginning of the Echo project he had stated that all claims for payment should go to Daniels, as Project Manager, for signing off. Daniels reported that the Budget carries \$50,000 for the last of three payments for the launch. While it is true that the launch cost is \$125,000 to pay the Russians, SpaceQuest is charging AMSAT \$10,000 for customs charges and \$15,000 for transporting and installing Echo on the launch vehicle. Daniels also expressed concern about travel costs for the integration activities. Haighton asked for Daniel's best estimate for 2004 and the reply was \$3000 to \$4000 for travel. He stated that the \$10,000 amount is just for going overseas and some provision for internal travel is needed. Daniels added that SpaceQuest is owed \$2000 for a wiring harness plus \$2000 more for the orientation magnet.

Haighton asked that Daniels and McFadin convey their thoughts to Feller about the accounting system. McFadin, citing his experience with P3D, said that one reason AMSAT had a hard time controlling costs is that not all the activity and reports went through the Project Manager. Hambly remarked that if the project manager first finds out about expenditures in an expense report it is very hard to control a project.

Haighton called upon Meisse to present comments about buying flight insurance for Echo. Meisse said the estimate now is 3-10% of the insured face value so our cost would be \$15,000-\$50,000 to cover its travel from the place of construction to the launch site, ignition of the vehicle's engines, achievement of apogee and perigee as specified within an established window and then long term life insurance on the satellite. Clark added that there were two more types of insurance to consider. One is liability insurance in the event that the launcher went down and our satellite hit someone. Another type is travel insurance for the satellite. Meisse said he is requesting a bid for each of those types of insurance. Clark said that liability and travel insurance was a common thing for us to have. Meisse declared that there is also an emotional issue involved should Echo fail, so we should think long and hard before counting out the purchase of insurance. Then he asked that recording stop for his next comment.

[Recording resumed.] Hambly added that we could order another Echo and have it up quickly, so it might make more sense to have insurance than it did for prior satellites. Clark suggested getting rates also for the SS-19 because some of our future satellites might be launched on those vehicles. Hambly declared that the insurance information will be needed very soon if we were to take advantage of it. Meisse said he would get it.

C. P3E

Daniels announced that Meinzer had sent word that things were going well with P3E although a tank had developed a sealant problem. He described P3E as basically an OSCAR-13. Feller reported that the builders had submitted a request with the IARU frequency coordinators. Haighton observed that the request covered a wide spectrum of frequencies including 2m, 70 cm, L-band, S-band and 10 GHz. Clark added that there is also a narrow uplink at 5.6 GHz. Haighton noted that while information about Eagle will be relatively open, P3E is absolutely closed and there is little information available and it is given out only on a need to know basis.

D. Other Satellites

Haighton reported that VUSat was due to be flying now but it had a problem with vibration testing and had been delayed. He reported that KiwiSat from New Zealand is about the size of a microsat and they were anxiously looking for a launch by the Russians. Haighton also noted that BlueSat, being built by the University of New South Wales, two years ago had been at least 80% complete. Haighton mentioned that there is another satellite being put together by an Australian group and like the other groups, the cost of a launch is their biggest problem. Clark declared that almost the same could be said for CESat that had been 70% complete for at least 4 years. Clark reminded that the cost to launch an ADAPS, even divided among 12 small satellites, would still be about twice the price of a Russian launch.

McFadin suggested the possibility of getting the Russians to deploy satellites from their Progress ISS supply freighter as they have in the past. He described this as taking the satellite up in the Progress to the ISS then just before deorbiting they put the payload out along with the trash. Such a low orbit lasted only about a month. Haighton commented that such an orbit might be more appropriate for Cubesats. McFadin said this plan could be a real possibility if their satellites were built to meet the special safety requirements of the human space flight program such as providing three ways to inhibit transmission before deployment. McFadin declared that he would bring up the subject of such a launch when he traveled to Moscow in the spring. McFadin opined that NASA would be pleased to find another way to deploy these small Cubesats because deploying them from 800 km did present a serious problem.

Employee Performance and Compensation Review

The meeting reconvened the next day in closed session limited strictly to voting members of the Board at approximately 8:30 A.M. to deal with administrative matters. No record was made of this session.

When the open session resumed, Martha declared that if there were inputs about her performance as Manager they should have come from the President and at a different time and place, not at the Board meeting. She opined that in regard to her position as Corporate Secretary the Board had a responsibility to provide feedback at a Board meeting. Then, the review that took place there could be made open to her presence without problems. Martha expressed that she wanted feedback from the Board members on any problems she should address. Hambly stated that it is important that we all give each other that kind of information. He also expressed concern that in recent years the adjustments made to her salary were based more on the state of AMSAT's financial health than on Martha's performance. Haighton agreed and stated that next year the employee review will be done her way.

Review of Auditor's Report

Treasurer Feller reported that the auditor's report for the year 2002 prepared by the firm of Verkoouteren, Auerbach, Olsen and Co. had been posted to the Web site as well as the Audited Financial Statement covering the year 2001. He reported that the auditor had remarked that she enjoyed coming to our office to do the audit because the books were in order and her random tests indicated everything is in good shape. Feller commented that in his opinion our fiscal house is very much in order and he asked for motions to 1) accept the auditor's report as delivered and 2) retain the services of this accounting firm for the coming year. Clark moved to accept both motions, Meisse seconded and both proposals were accepted by a unanimous vote.

Education

Clark asked that the Board consider the situation that for several years the position of VP, Education is unfilled. Haighton commented that it had been for 2½ years. Clark suggested that the executives of the organization needed to reconsider that this activity



should be split into totally separated departments that covered e.g., grades K-12 and university activities. He thought that this arrangement would be easier to administer and much more productive. Haighton declared that Clark had echoed what he had been thinking for the past two years. Haighton agreed that two offices should be created focused on different educational levels and declared that it will be done within the week. In response to a question from Meisse, Haighton said there will be a VP, University Affairs and a VP, Primary Education.

Meisse contended that we needed to carefully select our partners and that Education and science were the best ones we could get because in 10 years our bands are likely to be gone and it won't be to the universities but rather it will be to commercial interests. He declared that we need allies that we can live with and education and science are two of the finest things politically and in reality. Klein maintained that there is a potential for funding from foundations because the training of young people to become engineers and scientists is an important thing that is now being recognized. He thought we could obtain some of those funds to help with the cost of mentoring, design reviews and hardware development. Klein added that another aspect for AMSAT to consider is developing hardware for these universities because the schools are weak in the area of communications. He characterized working with universities as a win-win situation. Haighton noted that this reflected back to Meisse's earlier statement about going out for outside funding. He thought this would be our only chance to get outside funding.

VP, Government Liaison Klein reviewed Jan King's report of the Small Satellite Conference. King had noted that there was little other representation by AMSAT there other than Jim White. Martha said that Bauer was unable to attend because of illness. Hambly reported that those who heard King speak perceived that AMSAT had a very direct representation there. Klein concluded that the Board needed to formulate a policy to define our relationship to the small satellite community and tell the university people that we want to work with them. Hambly noted that among his "campaign promises" he had stated that AMSAT's relationship with the universities had to be improved and be assigned a high strategic priority. He believed that we were on the road toward improving those relationships and developing a source of the best and brightest potential new AMSAT members.

Haighton asked each person to take an objective look at the entire question of where AMSAT should be going in the area of education so that a suitable paper could be developed and presented to the Board. The Board members were asked to read the paper carefully, adjust it, agree or disagree and then accept or reject the result. He cautioned that we are getting a lot of bad publicity and we can't afford to let that continue. Hambly declared that the paper had to recognize the irreconcilable views and must not ignore nor minimize them. Clark suggested adding the names of six persons who could make significant contributions to the paper. He identified them as Jan King, Steve Horan, Frank Bauer, Jim White, Dave Filbert and Ron Parise. Tynan added the name of Jim Akers to the list.

Clark recommended that AMSAT have a strong presence at the Cubesat meeting at Santa Clara University in April 2004. Clark said if that is agreed upon there must be travel budgeted for educational coordination.

McFadin reported on related happenings in Florida. He said there were several universities very interested in space and satellites and that that he had traveled to Embry-Riddle and UCF as a mentor. McFadin claimed that the world of mentoring is alive and well and needed to be expanded. He said the students knew that he was an AMSAT member although not officially representing AMSAT. McFadin continued, saying that the students wanted to hear about the guidelines that AMSAT had

developed and he opined that they would abide by them. Hambly declared that mentoring policy is something the Board needed to tackle for itself because it is too important to delegate.

Clark mentioned that with regard to mentoring at universities, McFadin's was done at a local school where things could be done on a scheduled basis. For more remote locations a service we could provide would be to have several AMSAT people either conduct or participate in design reviews of their projects. He reminded that this was the way the very successful MOST project got started.

AMSAT's Financial Condition and Outlook

Haighton remarked that he would like to know more about AMSAT's philosophy of investing. Feller replied that the view has been to follow a fairly conservative and diversified path to maintain access while trying to obtain a reasonable yield. He added that we do not take big risks trying to make big gains. Haighton noted that everyone on the Board received the monthly financial statement although most did not get the statement of assets. Haighton declared that at least the first two pages of the Merrill Lynch investment information should also be sent to the Board members. Meisse thought that Merrill Lynch could supply their reports in an electronic format.

Feller asked that the Board let him and Martha know what changes they would like. McFadin and Hambly said they would like to have the financial data in a spreadsheet. McFadin added that he would like to have a greater ability to track projects.

Feller continued his report saying that the present outlook depended heavily on the ability of the Corporation to raise money. Haighton reminded that bringing more in members would also increase the expenditures. Hambly declared that for a new member there is an incremental increase in income that is highly leveraged in our favor because the cost increase is small. While a present member's dues may just cover their cost, for the next new one 80% of it may be to the good. McFadin asked if the membership dues covered the cost of the membership? Haighton replied "just" and Clark added that historically that had been the case. McLamb asserted that was only true if income from the President's Club was included. Both Feller and Saragovitz disagreed stating that it did not include President's Club income. McLamb maintained that the terms being used did not seem to be defined the same by everyone participating and he would follow-up with Feller and Saragovitz later. Hambly declared that this is not an organization that could survive at the current membership level. Membership levels needed to be at least 20% and preferably 100% higher, as they once were. McFadin contended that if we cut out all projects and provided no additional services for our members, we did not need to exist. Hambly stated that this was the conclusion of those attending the previous Board meeting and it had been decided then that the first priority of the organization is to launch Echo. An Echo success will help us increase income. Then we will move ahead with more projects in concert with raising more money. We need Echo's success to start the process of becoming healthy. Baines observed that because we dipped into the cash reserves to pay for Echo we are now trying to recoup those reserves. Clark reminded that this situation is no different than it had been 20 years ago when to do any projects we had to go out and raise the money separately. Feller added for the benefit of the new members, that it had been determined that there is very little to cut from the expenses. Baines opined that the direction we take on some of the thorny issues like the Web site may create additional expenses to achieve the level of technology needed. Hambly announced that Steve Diggs is working to get the AMSAT Web Store facility back on line and this would be a high priority.

Feller reported that the income was estimated to be \$293,650. This excluded income from a possible grant

and included only a token amount from the Echo launch campaign. The estimated amount of expenses amounted to \$373,429 leaving us with a net deficit of about \$80,000. He stated that there were three categories of money that he kept track of for tax purposes. Our management and overhead costs were about 16% of our budget, fundraising about 18% and money spent for programs amounted to about 67%. McFadin asked what that percentage is for most charities? Feller replied that ours is typical but we had usually done better. Feller recommended that it would be wise to try to keep the percentage for programs higher while keeping the overhead and fundraising lower. He added that we owed our accountants a debt of gratitude for their good work and to Martha as well for seeing that we could account for the money. Clark asked how much do the accountants cost us? Feller replied that the cost is \$8000 per year. Martha added that in addition to the audit, they prepared the federal and state tax returns. Feller answered that we were getting excellent service to the point where we can go down a few floors in our building to ask about a problem.

There were no further questions and Haighton asked how the Board wanted to treat the Budget as it now stood. He added that he didn't expect that much more information would be generated before January 1, 2004. Hambly encouraged that the Board revisit the Budget at each meeting. It was Haighton's thinking on this subject, as well as that of his predecessors, that the Budget is nothing more than a guide. It is something that he would not knowingly overspend by more than 5% without referring it to the Board but at the same time there must be the operating flexibility to act should there be an opportunity.

Clark made and Hambly seconded a motion to approve the Budget as provided to the Board by Treasurer Feller.

McFadin noted that \$6000 had been allocated to Eagle and \$2000 to Human Space Flight for rent of the Orlando lab. He questioned why that amount had been budgeted for Eagle? Martha replied that she and Haighton had come up with a formula where it is divided between Human Space Flight and Future Projects. Haighton added that they had reduced the amount for Human Space Flight and it was his belief that the remainder of the Orlando lab should be budgeted under Eagle because it is the lab that we intend to reactivate for Eagle. McFadin advised that he had looked for alternative locations but found that the alternatives would be costly.

Feller called for the question of whether the Budget is approved. The vote in favor was unanimous.

Comments on the Election

Martha remarked that there was little to comment on although there had been a problem caused by the printing company. They promptly corrected it at their expense. She reported that there were more votes cast this year than the last. Thanks were expressed to Bill Hook for his careful count of the votes and his recounting twice when the outcome appeared to be close. No errors in counting were found. Baines asked what was the percentage of members voting? The number was estimated to be approximately 25%. Haighton opined that it helped that there were eight good candidates on the ballot and he would like to see more candidates and a good race again in 2004.

Proposed Revisions to the Reimbursement Procedures

Feller began by reminding that the proposed new policy had been circulated by e-mail several months before. He suggested tabling this topic until the newer members on the Board had an opportunity to review the document. Hambly agreed that the subject should be tabled. Feller implored the Board and Officers to read it and provide feedback. Hambly recommended that footnotes be attached to the document showing the suggestions that had not been accepted. This would prevent ideas from being lost. McFadin stated that he

some immediate concerns because of his impending trip to Moscow. Martha advised that the League would pay for that and it would be necessary to abide by their travel policy. McFadin declared that if he is traveling for AMSAT he is going to follow AMSAT's rules. Hambly asked for a copy of the ARRL policy to review. Martha announced that for the present meeting the policy that Feller had published would be in force.

Potential Bylaws Changes

Hambly requested that this item be deleted from the Agenda but remain as an open action to be discussed at some undetermined date in the future.

Strategic Planning

Clark prefaced his suggestions with the statement that at this meeting there had been discussion of many tactical issues for the organization but there were some serious strategic and long-term issues about which the Board needed to think. He stated that the organization lacked the feeling that the Board members and Officers were part of a team. Clark said he had been impressed by TAPR's effort to define its present role since their original role of doing TNC kits had outlived its existence. Their board members plus one outside individual spent a day trying to answer what the organization is and what were the key topics that needed thought, discussion and development? Clark concluded by saying that he wanted our Board to think about how to develop a Strategic Plan that actually means something. He declared that it should provide the organization with more cohesion and have us working together.

Hambly asked that at future meetings the Strategic Plan be made the primary topic and receive appropriate attention at the beginning of the meeting. He emphasized that he was not talking about a document, but the whole of strategic planning. He further recommended that much of the minutiae and trivia not be included in the next Agenda. His approach toward organizing and prioritizing a meeting of the Board would be, a) strategic planning and its subparts, b) policy issues and c) various issues relating to the Board's relations with the executives. He declared that the Board's responsibility is to proclaim to the entire community its vision, passion and what policies it wants in place to guide the day-to-day activities to achieve that vision.

Baines opined that because there were new Board members and members who were not part of that original process, they might want to consider starting from scratch. They would then create a plan that belonged to the Board. Clark noted that there were some glaring omissions in the existing Strategic Plan document such as the absence of any mention of manned space flight. The members agreed that this should have been mentioned. Clark said another topic that needed to be carefully addressed is the relationship with the university community. He added, we should think about all those "boxes" we had put ourselves in where we were against something. He suggested that we should instead look for ways "we can be for something".

Baines suggested finding out what TAPR had achieved now that they've had at least one teleconference since the DCC. Baines also suggested learning what John Youngblood had brought to it as a facilitator.

Haighton asked McFadin to make the arrangements for the next Board meeting at the Orlando Travel Lodge where the rates were known to be reasonable. Baines asked which officers should be present to provide input? Hambly replied that for the purpose of providing ideas for all aspects of strategic planning, the presence of all persons was required so that it would provide a sense of ownership. Clark recommended that Bauer or a senior ARISS member attend the meeting and Haighton agreed.

Baines asked if funds had been budgeted for this trip? Haighton replied that he would look into it.

Review and Documentation of Action Items

Write up an NDA agreement, Hambly

Investigate having the Board meeting prior to the AGM in 2004, Bauer

Identify an Information Coordinator in the US for the ARISS program

Write a paper describing the benefits of the ARISS program and use it for promotional purposes

Consider a mission of an external payload on the ISS

Need to develop a Board consensus opinion on rulemaking activities

Implement the eBay hardware sales program, Haighton

Consider Web page redesign and other information technology projects, Haighton, Hambly

Write up a policy position paper for relations with the university community, Haighton

Have an AMSAT representative attend the 2004 Small Satellite Conference

Divide the VP Education into two positions. VP University Education & VP Primary Education, Haighton

Send draft of travel policy. Board Members to send comments back to Feller.

Investigate teleconferencing options, Hambly/Paige

Identify people to fill 5 key volunteer positions, Haighton

- a. Journal Editor
- b. Marketing
- c. Public Relations
- d. Membership
- e. Web page Designer

Martha suggested putting out a call for help on AMSAT-bb. Haighton said he would take care of that.

Recognition

Art Feller, W4ART, for all the assistance he has provided to Martha, not just as a Treasurer but also as a volunteer.

Bernie Keiser, W4SW, who secured the cooperation of the FCC to successfully attack cordless telephone interference to the AO-40 downlink.

The Toronto local organizing committee who made the arrangements for this Annual Meeting and their efforts ensuring that everything went very well.

Bob Bruninga, WB4APR, for his efforts in advancing innovative and low cost satellites.

Jan King, W3GEY/VK4GEY, for his efforts in multiple areas above and beyond the call of duty.

Other groups that have tried to provide satellites of interest including the new group in India and we wish them success when VUSAT is launched.

The CanX-1 group in Toronto for their innovative use of a Cubesat.

To the MOST team for allowing AMSAT to work with them on a very successful satellite.

Gould Smith, W4SXM, for producing the Area Coordinators Toolkit CDs and his paper at the Symposium that provided needed documentation on all the launches of the satellites of interest.

Jim Sanford, WB4GCS, for updating the Area Coordinator list.

Emily Clark, W0EEC, an Area Coordinator who represented AMSAT at Pacificon.

Hans Van de Groenendaal, ZS6AKV, for getting the IARU frequency coordination process functioning.

Santa Rosa Jr. College for their work on Eagle sensors and module boxes.

Frank Bauer, KA3HDO, for his years of effort supporting ARISS.

Cliff Buttschardt, K7RR, for his continuing efforts to bring sanity to the Cubesat community.

Phil Karn, KA9Q, who, despite all the bricks thrown at him, continued advancing his system for FEC coded telemetry from AO-40.

Wrap-up and Closing of the Meeting

Haighton read a letter dated February 15, 2003 recently received from Richard Limebear of AMSAT-UK. In summary, the letter announced that AMSAT-UK decided that consideration would be given to sponsoring DXpeditions to encourage the use of amateur satellites. Application should be made to the AMSAT-UK Secretary. AMSAT-UK is prepared to donate about £100 (\$150 USD) for up to three or four DXpeditions per year.

Haighton asked for comments on this matter. Clark suggested that he would have added to Limebear's list a note that exceptions would be considered on a case-by-case basis, e.g. the fellow who spent a year and a half in North Korea and needed equipment. Heck stated that anyone could ask for something like that. He added that since AMSAT-UK did not have a satellite building program this is one thing they could do to encourage satellite operation in general. McLamb asked Heck to send the letter to him to transmit on ANS. Baines remarked he could also help publicize it. McFadin thought AMSAT-UK's program is a "great idea". Hambly recommended that we should strongly endorse what AMSAT-UK is doing now.

Clark suggested that rather than adjourning, the meeting should be continued by e-mail or whatever means is chosen so that subsequent decisions would be legitimate actions of the Board. Hambly declared that the Board as a future agenda item should establish rules for electronic meetings. Hambly explained that the Bylaws suggest that we should have rules covering meetings by telephone, e-mail, EchoLink or whatever. He offered that it would not be difficult to establish a few simple rules relating to how votes were taken and deliberations carried out. This would ensure it is understood when the resolution is valid. Feller declared that the members should receive notice of these actions. Hambly suggested that the President ask someone to propose a simple set of rules for the Board to consider.

Haighton asked that if there was anything further "for the Good of AMSAT"? Nothing was suggested and the meeting recessed. ☸



Please support AMSAT-NA.
Thanks!



AO-40 Battery Event

By Lee McLamb, KU4OS, KU4OS@amsat.org

As most readers are aware by now AO-40 fell silent on 27 January 2004 at 0058 UTC. This article will review the configuration of AO-40's power system, the sequence of events on orbits 1486-1488 as well as the current results of telemetry analysis, lab testing and recovery efforts.

AO-40 Power

A functional block diagram of AO-40's power system is shown in Figure 1. Since there are a total of six solar panels, two solar panels are connected to each of the three Battery Charge Regulators (BCR). BCR #1 is connected to panels 1

and 6, which are the two solar panels attached directly to AO-40's frame. For thermal reasons these two panels only contain half the number of cells limiting their capacity to 50% as well. BCRs 2 and 3 are connected to the remaining panels and in addition to providing power for the 28V bus, provide redundant critical power at 10V. One 10V supply is provided from each BCR and is called 10V-C1 or 10V-C2. These redundant 10V buses provide power to AO-40's critical systems such as the command receivers and the Integrated Housekeeping Unit (IHU). Each module then internally combines these two 10V sources to ensure that they are always provided with power.

The three 28V outputs from the BCRs are combined together and provide power to operate AO-40's transmitters, relays, and other systems. The 28V bus is routed from the BCRs through the Power Supply Unit (PSU). The PSU contains the high current sensors for telemetry as well as the battery relay. The battery relay is a set of latching relays donated by Leach. These relays are the same type used on commercial geostationary satellites. The battery relay has three sets of 25A contacts connected together in parallel. This results in an overall capacity for the relay to handle a total of 75A. The battery relay provides the ability to connect either the Main or Auxiliary

Batteries to the 28V bus individually or to tie both batteries together in parallel. There is also a "Charger" option that connects the offline battery to the 28V bus through 25 ohm resistor to provide trickle charging and some isolation. There is no option for completely disconnecting both batteries and operating off of only the solar panels.

AO-40 does not have any solar panels on the top or bottom of the spacecraft. Because of this there was a concern that should it tumble into an attitude with the top or bottom toward the Sun, any system that would

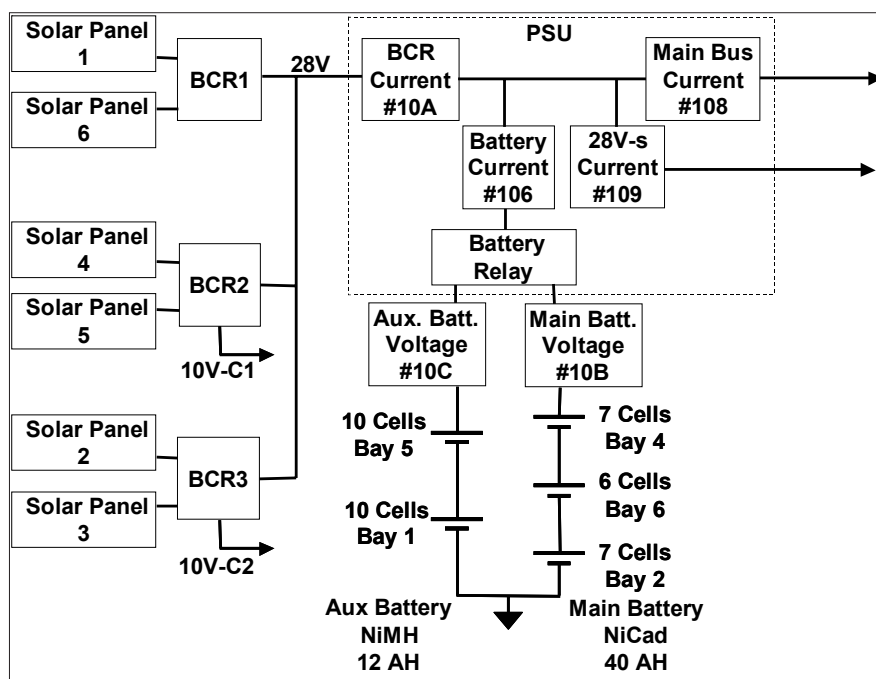


Figure 1
AO-40 power distribution functional block diagram. The numbers refer to telemetry measurement numbers in the AO-40 telemetry specification.

automatically disconnect the batteries based on low bus voltage could make a bad situation much worse. In fact, NASA's SOHO mission was experiencing just such a crisis as AO-40's power distribution design was being finalized.

AO-40 has two 28V battery systems installed. A picture of the Omni end of AO-40 with the panels removed showing ground test batteries installed is shown in Figure 2. The main battery is a string of twenty NiCad cells rated at 40 AH. The negative end of the battery is located in Bay 2 where 7 cells are mounted. The center 6 cells of the string are mounted in Bay 6. The final 7 cells are located in Bay 4 and provide the connection to the positive end of the Battery. The Auxiliary Battery consists of 20 NiMH, 20

AH cells. These 20 cells are divided into two groups of 10 cells mounted with the negative end in Bay 1 and the positive end in Bay 5.

January 2004 Events

January 2004 began nominally with AO-40 coming out of the most recent off-pointing season, starting to chase the Sun back to ALAT/ALON 0/0 and having resumed normal transponder operations. Figure 3 shows the typical main battery voltage profile during orbit 1485. During this orbit the telemetry data shows the battery voltage being maintained generally in the range of

28V to 29V. Also quite apparent in the data is the eclipse around Mean Anomaly (MA) 226-238.

On Sunday, 25 January 2004, during orbit 1486, AO-40's main battery began showing obvious signs of distress as shown in Figure 4. After recovering back to a normal 28V-29V following the eclipse at the end of the previous orbit, the voltage dropped to approximately 27V prior to transponder turn on at MA 40. With the additional load of the transponder, the voltage sagged even lower into the range of 25V-26V, until finally hitting the "LOW" voltage flag set point of 24.5V at MA

132. As a result of tripping the "LOW" voltage flag the transponders were automatically switched off. The main battery did recover back to 27V with the reduced load, but this was still below the expected 28V-29V. During the eclipse on orbit 1486 the main battery's voltage hit the S2 transmitter cutoff voltage of 24.0. Once AO-40 returned to sunlight and with the lightened load of having S2 turned off, the main battery voltage quickly recovered back to 29V.

Figure 5 shows the main battery voltage profile for orbit 1487. The main battery during orbit 1487 maintained almost 29V until the IHU commanded the S2 transmitter back on at MA 2. Once the load of the S2

transmitter was added the voltage fairly rapidly decayed back to near 26V and remained stable until entering the eclipse. As occurred on the previous orbit, the battery voltage quickly fell below the 24.0V S2 cutoff voltage settling to 23.4V as shown in the close-up of the eclipse in figure 5a. Twenty-three minutes later the "Extreme Low Voltage" flag was set when the voltage dropped below 23.4V. In response to this flag the IHU commanded all non-critical systems off and closed the relay connecting the Auxiliary Battery directly in parallel with the main battery. At the time of connection the aux battery was fully discharged and reading just 0.1V. Following the eclipse, the battery voltage again recovered as it had on the previous orbit although this time to a slightly lower 28V.

Orbit 1488 began much like the previous orbit. At MA 2 the IHU again commanded the S2 transmitter on and the battery voltage dropped again to near 26V. Since the aux battery voltage was not being logged by the Whole Orbit Data (WOD) routines, the first chance to assess its condition was when telemetry A-Blocks started being copied by ground stations at MA 8. As shown in Figure 6, from MA 8 through the end of the data, the aux. and main battery voltages tracked each other nearly identically. This is the expected result since the two batteries were tied directly together. At that point everything appeared stable and with the exception of having added the aux battery online very much like the previous orbit. Then, abruptly at 0039 UTC on 27 January 2004, the voltage dropped from 25.5V to 18.0V in the next telemetry sample 28 seconds later. A minute later, at the next MA tick, the IHU commanded the transmitter off with the voltage reading 17.1V. Command operator Stacey Mills, W4SM, was monitoring AO-40 as these events unfolded and reported, "I brought it back up manually twice, noting that the voltage was relatively stable at about 14 volts with heavy charge current." Stacey continued, "After letting things sit for a few minutes, a third attempt to start the S2 transmitter was not successful."

Orlando Lab Testing

AMSAT maintains a lab in the Orlando, FL area for the construction and testing of space hardware. The original Phase 3D (now AO-40) integration was done at the old lab location near Orlando International Airport, while some ARISS hardware and other projects have been done in the new location near Orlando Executive Airport. This will also be the site for the future integration of the Eagle Project. Lab Manager, Lou McFadin, W5DID and VP Engineering, Stan Wood, WA4NFY man the lab.

One of the first concerns was to try to determine the status of the aux battery, which had been stored in a discharged state on AO-40 for several years. Since the spacecraft had originally been assembled in Orlando, when

Lou while Lee McLamb, KU4OS, extracted a voltage vs. time profile from the telemetry data. When voltage was initially applied to the test cells to simulate the relay closing across the main battery at 23.3V, the initial inrush of current was 4-5A. In one minute the current flow had fallen to 100mA. Then the voltage was gradually increased to simulate coming out of eclipse based on the telemetry data. During this ramp up the maximum current was 1.42A. The profile was then followed through including a final rapid discharge to 14V.

Observations from the experiments in the lab included:

- The cells did not start proper charging until the voltage approached 27 to 28 volts.
- The cells only received a proper charging current for about 20 minutes.
- The charge level was probably less than 10 % of capacity.
- The rapid discharge caused a maximum current of 8 to 10 amps.
- At no time did any cell temperature rise more than 1 deg C.

Based on these results it is believed that the aux battery connection was a fairly benign event and certainly well within the 75A rating of the battery relay contacts. Further testing with the NiMH cells in the Lab has revealed that they remain in pretty good shape. After several charge/discharge cycles the cells recovered to an approximately 12 AH capacity.

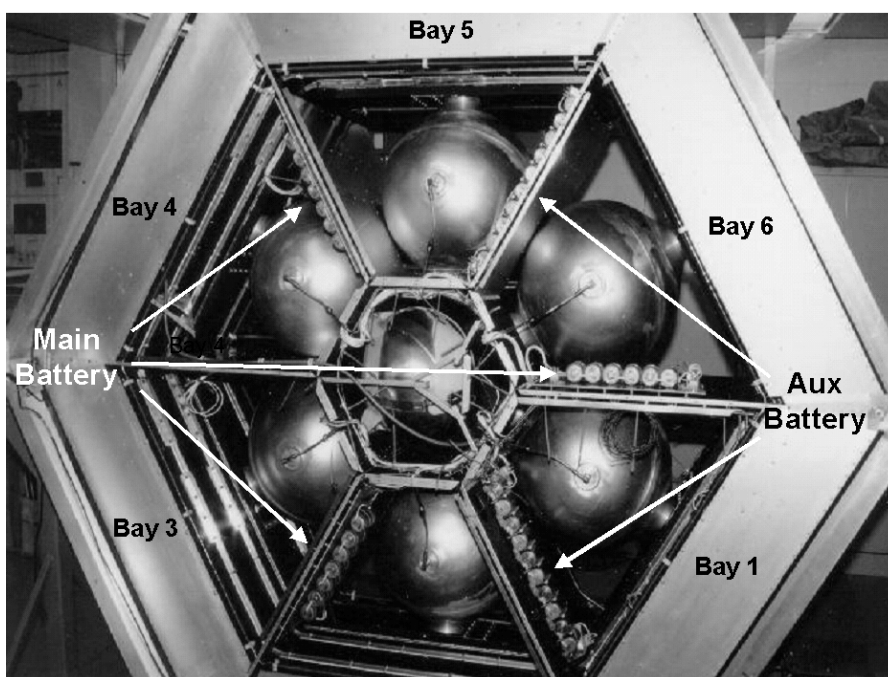


Figure 2
Omni end of AO-40 with ground test batteries installed.
(Baker & Jansson, 1986)

the cells for the aux battery were selected, eighteen remaining cells had been left stored in the lab. The last time that these cells had been charged was 26 June 1999. Initially voltage checks were made on the individual cells and they were found to be between 0.2V and 0.66V. Next charging checks were made using two single cells, which showed that even under a worst case situation the current flow through the battery relay was well within limits.

The second effort was to model the effect of closing the battery relay connecting a fully discharged aux battery in parallel with the 40 AH main battery. A test string of 10 cells (Figure 7) was assembled by Stan and

A third important piece of information provided by the Lab was the actuation voltage for the battery relay. From testing done on a spare relay it was established that the relay would operate reliably with a bus voltage as low as 12V. Below 12V, the relay would not operate.

Telemetry Analysis

In addition to the battery voltages discussed above, several other things were noted in the telemetry data. One of the most notable was the lack of a significant temperature rise to indicate where the energy from the batteries was going. Of the three sections of main battery only the one in bay 2 still had an operable temperature sensor after the

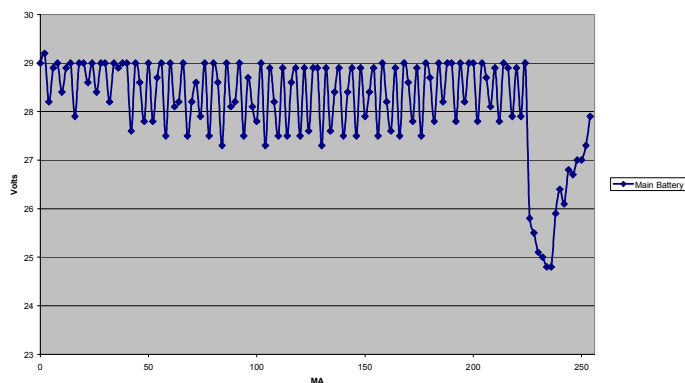


Figure 3 (above)
AO-40 Main Battery Voltage, Orbit 1485, 24-25 Jan 2004

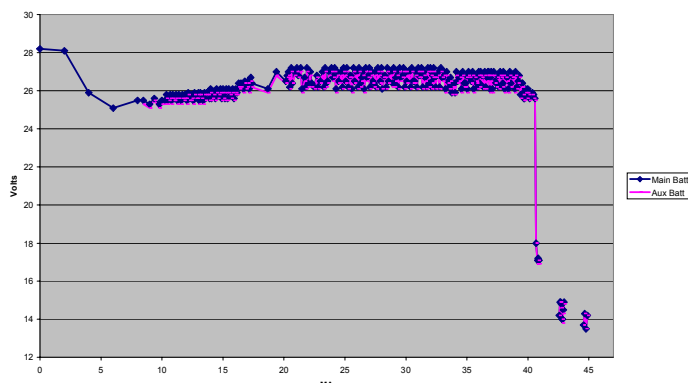


Figure 6 (above)
AO-40 Main & Aux. Battery voltages, Orbit 1488, 26-27 Jan 2004

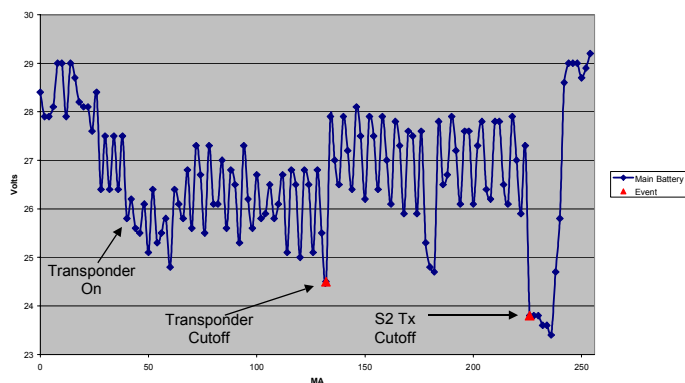


Figure 4 (above)
AO-40 Main Battery Voltage, Orbit 1486, 25-26 Jan 2004

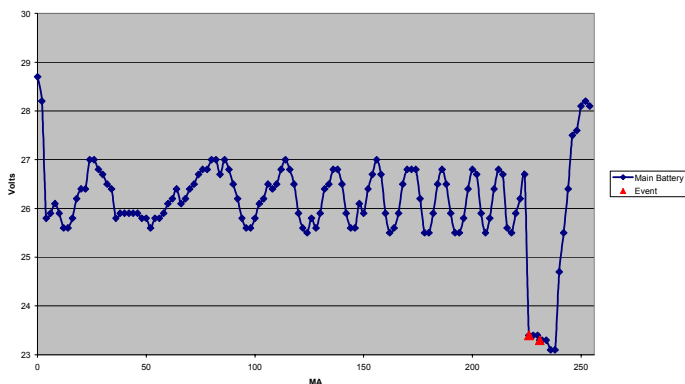


Figure 5 (above)
AO-40 Main Battery voltage, Orbit 1487, 26 Jan 2004

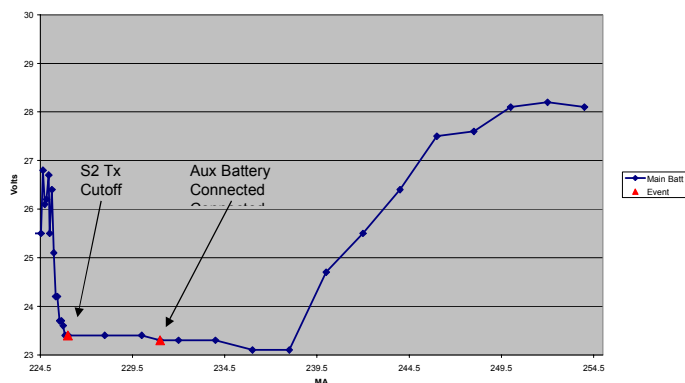


Figure 5a (above)
AO-40 Main Battery voltage, Orbit 1487, eclipse

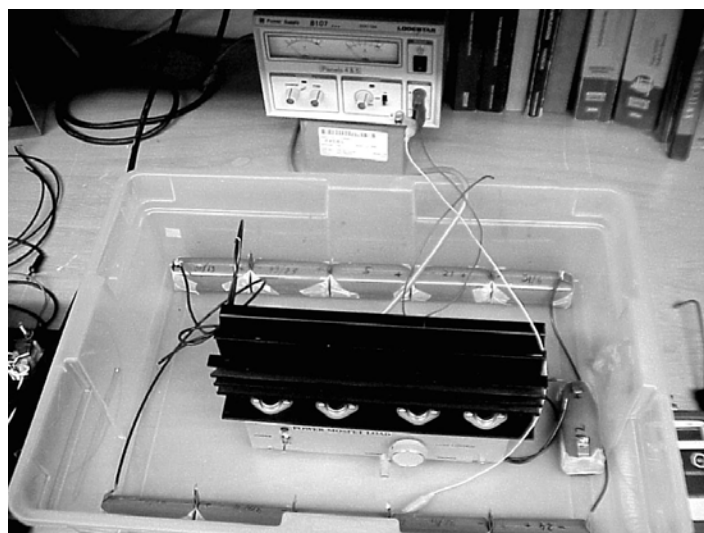


Figure 7 (above)
NiMH Aux. Battery simulation testing at the Orlando Lab
(McFadin, 2004, photo)

engine event several years ago. Both sensors on the aux battery were still working but registered only a very small change which may have been an artifact caused by the low voltage. The only significant temperature change was seen about ten minutes after the low-voltage “event”. The temperature of Heat Pipe 4 +X+Y jumps by 34.2 degrees C in just 14 seconds and continues to rise. Stacey observes that, “Given the timing of this change, its rapidity and the thermal inertia of the large, circumferential heat pipes it is difficult to believe that this is real.” Stacey also notes that, “this heat pipe sensor sits in a ‘benign’ area at the apex of panels 1 and 6, near the high-gain end of the spacecraft.” In addition, other items nearby show no accompanying change in temperature. One possibility is that a short on the main battery segment in Bay 1 might have generated enough localized heat (or even some hot metal spatter) to damage the Heat Pipe’s thermistor or, more likely, its wiring. However the expected rise on the cells in Bay 2 is not evident. So that interpretation is in question as well.

The current operating theory is that a catastrophic failure of some type occurred on the main battery. As a result of this the bus voltage is clamped somewhere in the 10V-12V range. However it should be noted that the available data is very limited and it is impossible to rule out other failure modes conclusively.

Recovery Efforts

Currently the recovery efforts are focused around the theory that the main battery has failed and the priority is on switching to the Auxiliary Battery. The Command Team is attempting to cycle the main battery off (aux battery on) and then turn the S2 Transmitter on each orbit using machine codes. The K-Band Transmitter is also being tried on occasion as weather and squint angles permit. At the end of each attempt the sequence to disconnect all transmitters is sent, to protect them from low voltage.

In February an attempt was made to listen for the leakage from the L1 receiver's LO with thanks to significant support from "Parkes Observatory" in Australia¹. The radio telescope has a diameter of 64 meters. For this attempt a 4 MHz wide spectrum with center frequency of 1097 MHz was scanned and a band of approx. +/- 20 kHz around the actual LO frequency was examined closely. Unfortunately no signals from AO-40 were detected. The fact that the L-band receiver's LO was not heard does not necessarily mean that the receiver was not operating. The receivers of Parkes are don't normally operate below 1.25 GHz. Another unknown is exactly how well the L1 receiver's LO is shielded or how much of the signal would leak through the antenna to the outside world. A note of special thanks is extended to Brett Dawson, VK2CBD, and the team of Parkes observatory, especially to Dr. John Reynolds (Officer in Charge) and John Sarkissian (Operations Scientist).

On 09 March 2004, Command Station operator Colin Hurst, VK5HI, reported that during orbit 1541, after sending a twelve block sequence of 3*(Reset, Tx-Off, Reset, Tx-On), he noticed a noise peak of 4 to 5 db, in the vicinity of expected beacon frequency. The width of this peak was about 5 kHz. The noise peak then disappeared approximately 2 seconds after the Tx-Off command was sent. Following this a series of Aux-Batt commands were sent.

The attitude and spin rates are quite well calibrated and can be forecast well into the future. As an example, AO-40 is currently rotating at 3.5 RPM and it will take approximately 4 years to slow to 3.0 RPM. Without active magnetorquing the so-called "Mystery Effect" will move ALON by -11.8 degrees per week. This will cause the optimum commanding window to move earlier in the orbit. The changing attitude combined with other orbital effects also results in a 68-day cycle of optimal sun angles. On 15 March 2004 available solar power was limited to just a few percent of normal as the Sun shone almost directly on

the Omni end of the satellite. By 18 April 2004 available solar power will again peak at 100%. All of the factors intertwine in ways such that recent short-term results should not be taken as a sign of the eventual long-term outcome. Recovery efforts are continuing and different things and combinations will be explored as dictated by power, time and on-going analysis.

Recognition

I'd like to thank Peter Guelzow, DB2OS, Colin Hurst, Lou McFadin, Stacey Mills and Stan Wood for answering questions and providing information for this article. Also, thanks to Paul Willmott, VP9MU, for running the telemetry archive and the ground stations that provide their telemetry files as well as those who provided real-time data through the Goddard ARC server.

Notes:

1. <http://www.parkes.atnf.csiro.au/>
2. <http://www.amsat-dl.org/p3d/index.html>



Field Day 2004

**June 26 1800 UTC to
June 27 2100 UTC**

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some birds!**

(see article beginning on page 30)

AMSAT Field Day Summary Sheet

AMSAT Satellite Summary Sheet - 2004

Satellite and number of Voice QSO's
AO-27 (example)

Satellite and number of CW/RTTY/PSK31 etc. QSO's
FO-29 (example)

Satellite and Up/Downloads
UO11 (example)

Score Calculation:

Total Voice QSO's

x 1 =

Total CW/RTTY/PSK31 QSO's

x 3 =

Total Up/Downloads

x 3 =

Grand Total

=

Please provide the following information:

Your Field Day Callsign

Your Group Name

ARRL Field Day Classification

ARRL Section

Power Source (Select 1):

Emergency

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Your name and home call

Home address

Any Comments



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FM Satellite DX'ing

Jim Savard, VE3SJR, likes to work the FM birds from James Bay Ontario. In these pictures Jim is working **G8ATE** from Moose Factory Island (E091). Equipment is an Icom W32A, an Arrow Antenna with a mast mounted preamplifier from Advanced Receiver Research and Nova for Windows Satellite Tracking Program.



AMSAT - Puerto Rico Organized

On April 12th, new AMSAT coordinator for Puerto Rico, Juan Ramon Vazquez, KP4SAT, presented his ideas to form a local AMSAT organization during the monthly meeting of the Puerto Rico DX club in the University of PR in Rio Piedras paving the way to fulfill interest in those who like satellite DXing.

He explained with a PowerPoint presentation his intentions, which include creating certificates for satellite contacts, QSL'ing, presentation at local meetings and hamfests, a local Web site and a few projects like high altitude balloons with a beacon and/or various Amateur Radio modes and in the future to get involved with the university students of engineering to develop what may be the first telecommunications satellite built in Puerto Rico. He also wants to bring new members to AMSAT-NA and revive the interest that there was a few years ago.

Those who want to be part of the new organization or want more information can write to kp4sat@amsat.org or wp3gw@amsat.org. There will be another presentation on Sunday, June 6th on the Caribbean Amateur Radio Club hamfest in the city of Arecibo beside the Pancho Padilla Basketball court.



Juan Ramon, KP4SAT during his presentation to AMSAT-PR



Some who will be a part of the AMSAT-PR organization: Francisco, WP4CNU; Juan, KP4SAT; Angel, WP3GW; Jaime, KP4DR

Photos by KP4DR and WP3GW

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MKU 10 OSCAR 10.451 GHz. Down Converter
MKU 24 G2 OSCAR 2.4 GHz. Transverter 1 Watt
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2004 AMSAT FIELD DAY COMPETITION

It's that time of year again: summer and Field Day! Each year the American Radio Relay League (ARRL) sponsors Field Day as an emergency preparedness exercise. The event takes place during a 24-hour period on the fourth weekend of June. For 2004 the event takes place during a 27-hour period on the fourth full weekend of June, from 1800 UTC on Saturday June 26, 2004 through 2100 UTC on Sunday June 27, 2004. The Radio Amateur Satellite Corporation (AMSAT) promotes its own version of Field Day for operation via the HamSats, held concurrently with the ARRL event. Those who set up prior to 1800 UTC

on June 26 can operate only 24 hours.

If you are considering ONLY the FM voice satellites like AMRAD-OSCAR-27 or SaudiSat-Oscar 50 for your AMSAT Field Day focus, don't, unless you are simply hoping to make one contact for the ARRL rules bonus points. The congestion on FM LEO satellites was so intense in 2000 that we must limit their use to one-QSO-per-FM-satellite. This includes the International Space Station. You will be allowed one QSO if the ISS is operating voice. You will also be allowed one digital QSO with the ISS and PCSat.

The format for the message exchange on the ISS or PCSat packet is an unproto packet to the other station (3-way exchange required) with all the same information as normally exchanged for ARRL Field Day, e.g.:

W6NWG de KK5DO 2A STX
KK5DO de W6NWG QSL 5A SDG
W6NWG de KK5DO QSL

If you have worked the satellites on Field Day in recent years, you may have noticed a lot of good contacts can be made on some of the less-populated, low-earth-orbit satellites like Fuji-OSCAR-29. During Field Day the transponders come alive like 20

meters on a weekend. The good news is that the transponders on these satellites will support multiple simultaneous contacts. The bad news is that you can't use FM, just low duty-cycle modes like SSB and CW. AMSAT-OSCAR-10 can also be a lot of fun on Field Day if the solar panels are properly illuminated and it is in a good position in the sky for Field Day (it has not been usable in well over a year). And, of course, the big news this year is AO-40, which is not operational so other plans must be made such as FO-29 and AO-7.

THE 2004 AMSAT FIELD DAY RULES

The AMSAT Field Day 2004 event is open to all Amateur Radio operators. Amateurs are to use the exchange as specified in ARRL rules for Field Day. The AMSAT competition is to encourage the use of all amateur satellites, both analog and digital. Note that no points will be credited for any contacts beyond the ONE allowed via each single-channel FM satellite. Operators are encouraged not to make any extra contacts via these satellites (Ex: AO-27 & SO-50). CW contacts and digital contacts are worth three points as outlined below.

1. Analog Transponders

ARRL rules apply, except:

- Each phone, CW, and digital segment ON EACH SATELLITE TRANSPONDER is considered a separate band.
- CW and digital (RTTY, PSK-31, etc.) contacts count THREE points each.
- Only one contact is allowed via each single-channel FM satellite, AO-27 (1 phone), SO-41 (1 phone), SO-50 (1 phone), ISS (1 phone and 1 digital), PCSat (1 digital), etc.
- The use of more than one transmitter at the same time on a single satellite transponder is prohibited.

2. Digital Transponders

For the Pacsats (e.g., UO-22), each satellite is considered a separate band. Do not post "CQ" messages. Simply upload ONE greeting message to each satellite and download as many greeting messages as possible from each satellite. The subject of the uploaded file should be posted as Field Day Greetings, addressed to ALL. The purpose of this portion of the competition is to demonstrate digital satellite communications to other Field Day participants and observers. Do not reply to the Field Day Greetings addressed to ALL.

The following uploads and downloads count as three-point digital contacts.

- (a) Upload of a satellite Field Day Greetings file (one per satellite).
- (b) Download of Satellite Field Day Greetings files posted by other stations. Downloads of non-Field Day files or messages not addressed to ALL are not to be counted for the event. Save DIR listings and message files for later "proof of contact".

Please note AMSAT uploaded messages do not count for QSO points under the ARRL rules.

Satellite digipeat QSO's and APRS short-message contacts are worth three points each, but must be complete verified two-way exchanges. **Remember, only one digipeat contact is allowed for the ISS and one for PCSat.**

The use of terrestrial gateway stations to uplink/downlink is not allowed.

If FO-29 is active, the JA transponder can be used for analog CW and phone activities under the analog transponder rules, and the JD system can be used as a separate transponder under the digital rules.

Sample Satellite Field Day Greetings File:

"Greetings from W5BTS Field Day Satellite station near Katy, Texas, with 20 participants operating class 2A, in the AMSAT-Houston group with the Houston Amateur Television Society and the Houston QRP club. All the best and 73!"

Note that the message stated the call, name of the group, operating class, where they were located (the grid square would be helpful) and how many operators were in attendance.

3. Operating Class

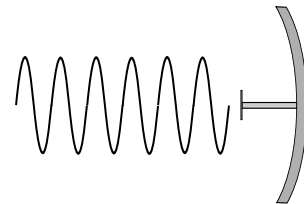
Stations operating portable and using emergency power (as per ARRL Field Day rules) are in a separate operating class from those at home connected to commercial power. On the report form simply check off Emergency or Commercial for the Power Source and be sure to specify your ARRL operating class (2A, 1C, etc.).

AND FINALLY...

The Satellite Summary Sheet should be used for submission of the AMSAT Field Day competition results to:

Bruce Paige, KK5DO
Vice President User Services
PO Box 310
Alief, TX 77410-0310.

Make sure to also send your Field Day photographs with your submission! The deadline for submissions is July 17, 2004. You can also send your entry sheet and digital photos via e-mail to kk5do@amsat.org. The first-place



emergency power/portable station will receive a plaque at the AMSAT General Meeting and Space Symposium in Washington, D.C., October 8-9, 2004. Certificates will be awarded for second and third place portable/emergency operation in addition to a certificate for the first-place home station running on emergency power. Stations submitting high, award-winning scores will be requested to send in dupe sheets for analog contacts and message listings for digital downloads.

You may have multiple rig difficulties, antenna failures, computer glitches, generator disasters, tropical storms and there may even be satellite problems, but the goal is to test your ability to operate in an emergency situation. Try different gear. Demonstrate satellite operations to hams that don't even know the HamSats exist. Test your equipment. Avoid making more than ONE contact via the FM-only voice HamSats or the ISS, and enjoy the event!

(See the recommended Field Day Summary Sheet on page 27 - ed. For questions contact Bruce, KK5DO at kk5do@amsat.org)

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Name _____		Call _____		Country _____		ZIP/PC _____	
Address _____		City _____		State/Prov _____		Exp _____	
Suggested donation \$20, but I'll give \$ _____		VISA/MasterCard No. _____		Signature _____		☐ Do not list my name in Journal	

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